Developing a web application to improve communication at a software company.

E. Dreyer

Research methodology for the Dissertation submitted in partial fulfillment of the requirements for the degree *Bsc in Information Technology Hons* at the Vaal Campus of the North-West University

Supervisor: Dr. Suné Van Der Linde

Co-supervisor: Luke Coetzee

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EU	European Union (Abbreviation)

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Chapter 1: Introduction

Communication plays an important role in our daily lives. In the corporate world, businesses rely on effective communication to succeed. Effective communication is essential for a business since it enhances engagement between employees and strengthens relationships with clients (Zambas, 2019). The overall efficiency in the work environment improves because of effective communication (EasyWorkNet, 2019).

In the software development industry, communication remains a vital component of the core business. A typical process followed in the software development industry entails a client communicating requirements to a project manager and, the project manager communicating the requirements to the developers. When those requirements are poorly communicated, it can affect the quality of the end product, waste time, resources and that translates to money being lost (EasyWorkNet, 2019). Thus, it is important for all the key stakeholders to have a good communication system.

For software development companies with junior software developers working on a project, good communication is essential, because a small miscommunication can escalate into losing a day of work, or until the project manager returns to the office after having a meeting somewhere else. The project manager can take hours to return, and a good communication system will help with time being wasted on projects.

The goal of this study is to develop a web application that can be used to enhance communication between developers and management at a South African software development company. The system will allow project software developers to have access to important information with ease.

In the next section, the background of the research will be discussed.

Keywords: design science research, productivity, communication, agile software development.

1.1. Background to the study

At a South African software development company where requirements are frequently being added or changed, the importance of communication increases. With the rapid growth of web-based applications project managers are constantly and easily communicating with clients (Dovleac, 2015).

According to Hoek (2018) the current process when developing software for a new project in term of communicating the requirements can be described as:

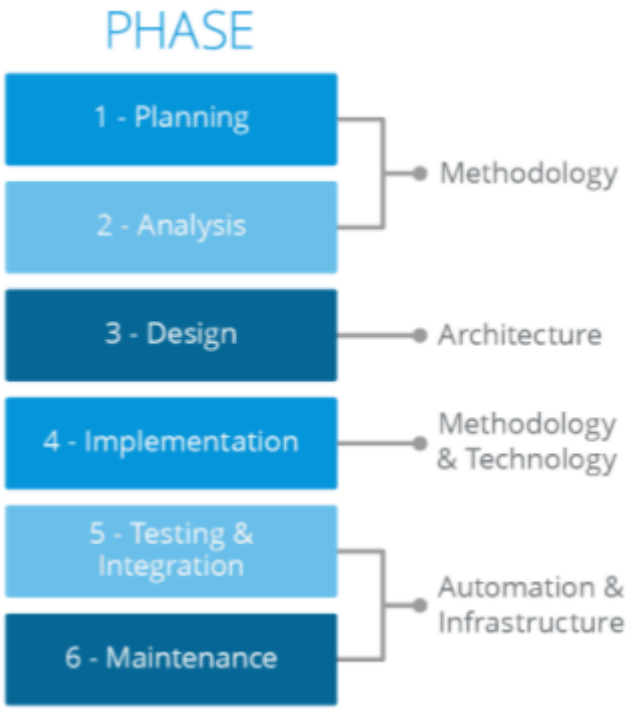

Figure 1: Processes when developing software (Hoek, 2018)

The methodology phase is to allow change in the business needs and adopt these changes. Architecture is there for a flexible solution design for allowing continuous business changes. Technology is where the company choses the right technology for the job to achieve best result. Automation is there to automate any time-consuming processes where infrastructure enables the project to create an infrastructure that can keep up with business changes and adaptations (Hoek, 2018).

For this study there will be a focus on the methodology phase (planning, analysis, and implementation) because of how the project manager communicates to the project

developers can still be difficult in smaller businesses where the project manager has more than one project. This can cause a project to lose valuable time, resources, and money.

A project manager can easily fall behind or forget about important information when it is not immediately communicated to the project developers. With information being available at a faster pace, the project developers can work on the requirements quicker, this will improve productivity and increase the project's success.

1.2. Problem statement

As programmers, we want to keep the most important tabs open but lack the number of screens needed to achieve this. We are not regularly on our phones to read messages, thus making it harder for important messages to reach the team or developer. When developers have to look at their phones periodically it lowers productivity and creativity (Schrader, 2018).

This is common in smaller companies where the project manager is constantly busy with meetings for more than one project. Meetings are not always at the office and the scope or requirements of the project can quickly change. This causes the planning, analysis, and implementation phases in the software development life cycle to become difficult when not done correctly.

For this reason, this study proposes to develop an artefact that will allow project managers and project developers to have access to a way of communicating and to access important information during the day. The research will be conducted using design science as it involves the creation of an artefact with means to improve an already existing state of practices as well as researching existing knowledge (Vijay Vaishnavi, 2004).

(i) Research questions to improve the design of the artefact are as follows:

1. How will design science help to develop the artefact?
2. What software will be needed to design the artefact?
3. What features need to be in the artefact?

1.3. Project description

The goal of this study is to create an artefact that will improve communication in a company by minimizing the number of programs that are open on a programmer's computer when working on a project. This study will give a solution to improve communication and productivity in the industry by using an artefact that project teams can use to send or upload important information.

The key concept is to have one web application showed on one screen in the office that is shared between project managers and project developers where everyone can see important information with ease. While focusing specifically on applications that can make it easier for project managers and project developers to communicate.

1.4. Aims and objectives of project

This study proposes the development of a communication web application that can easily be viewed in an office by all employees to allow easy access to important communication regarding specific software development projects. The primary and secondary objectives for the study are provided next.

1.4.1. Primary objective

To develop a web application for a South African software development company that allows for easy access to important communication relating to specific projects.

1.4.2. Secondary objectives

(i) Theoretical objectives

- Gain knowledge of design science research to guide the development of an artefact.
- To identify commonly used web applications in industry.

(ii) Empirical objectives

- To collect and analyse qualitative data in the form of an interview in order to understand what people in the software development industry need to make communication easier.

- To develop a communication web application that will provide easy access to desired communication.

1.5. Procedures and methods that will be used

Data for this study will be collected through an interview by a project manager that is already in the industry and will take place during the planning phase. This study will use qualitative content analysis. Qualitative content analysis has been defined as "a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns" (Hsieh & Shannon, 2005). The process will begin during the early stages of data collection.

For this study, the most applicable research methodology is design science research. Research methodology based on information technology is an outcome of design science (Vijay Vaishnavi, 2004). It focuses on the performance and development of artefacts, intending to improve an already functional artefact. Research in this discipline is seen as improving and understanding human performance (Kuechler, 2012).

The Vaishnavi process model as well as why this process model was chosen, is elaborated upon in the next section.

1.6. Process model for this research

With regards to Design Science Research this study will look at the Vaishnavi process model as well as the Peffers process model. The process model will establish the design as a coherent discipline (Mohammad Abooyee Ardakan, 2009) and aid to establish in what phase the project is at any given time.

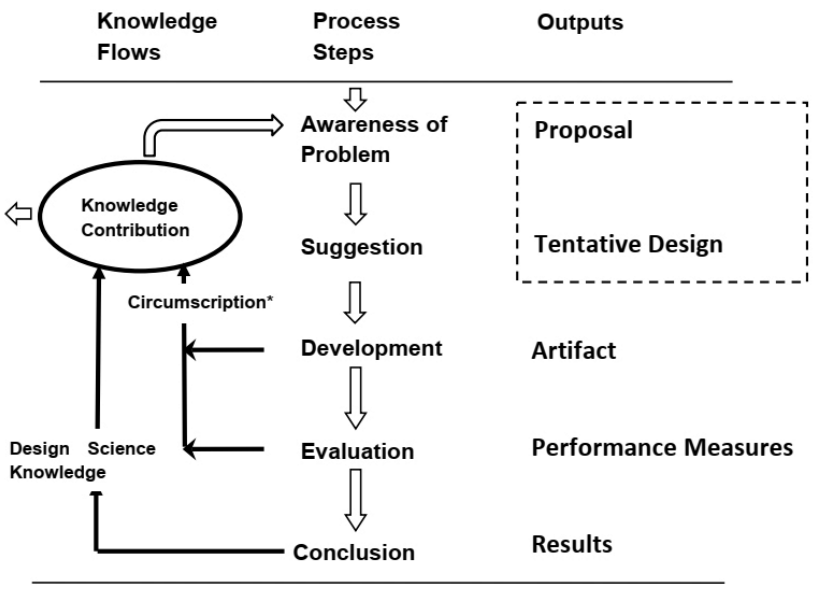

Figure 2: Vaishnavi Process Model (Vijay Vaishnavi, 2004)

The figure represents the process model by Vijay Vaishnavi (2004) an entails awareness of the problem, suggestion, development, evaluation, conclusion and will be discussed next.

(i) Awareness of problem

Multiple sources can be used for an awareness of a research problem. This includes identifying problems in a reference discipline or a new development in the industry. Part of this phase is becoming aware of the main problem and considering criteria for evaluating the artefact when it is done.

(ii) Suggestion

This phase is where new functionality is envisioned. Non-repeatability has been criticized in this phase of the design science research method. A Tentative Design of a prototype forms part of the proposal if approved by the researcher. In all research methods, this creativity step has necessary analogs, as it creates curiosity to develop an artefact.

(iii) Development

If the Tentative Design is approved by the researcher further development and implementation take place in this phase. Implementation techniques will depend on the artefact that will be created. Formal proof may be needed to show the correctness of the design, for example constructing an algorithm.

(iv) Evaluation

By following the criteria set in the awareness of the problem phase, deviations of what was expected are noted and must be tentatively explained. The result in this phase can lead to a new design because the criteria are not met.

(v) Conclusion

This phase is the end of the research cycle. The result of the research effort is typical, that of satisficing, where some deviations of the behavior of the artefact are revised.

1.7. Why the Vaishnavi process model

Compared to the process model developed by Peffers, the Peffers process model splits the "Awareness of problem" into two phases called "Identify Problem & Motivate and Define Objectives of a Solution"; puts the "Suggestion and Development phases" together in a single phase called "Design & Development"; splits the "Evaluation" phase in two phases called "Demonstration and Evaluation"; changes the name of the "Conclusion" phase as "Communication". A feature that distinguishes the Peffers model is the identification that from variety of contexts the design science research process can be initiated (Vijay Vaishnavi, 2004). This is shown in the figure bellow.

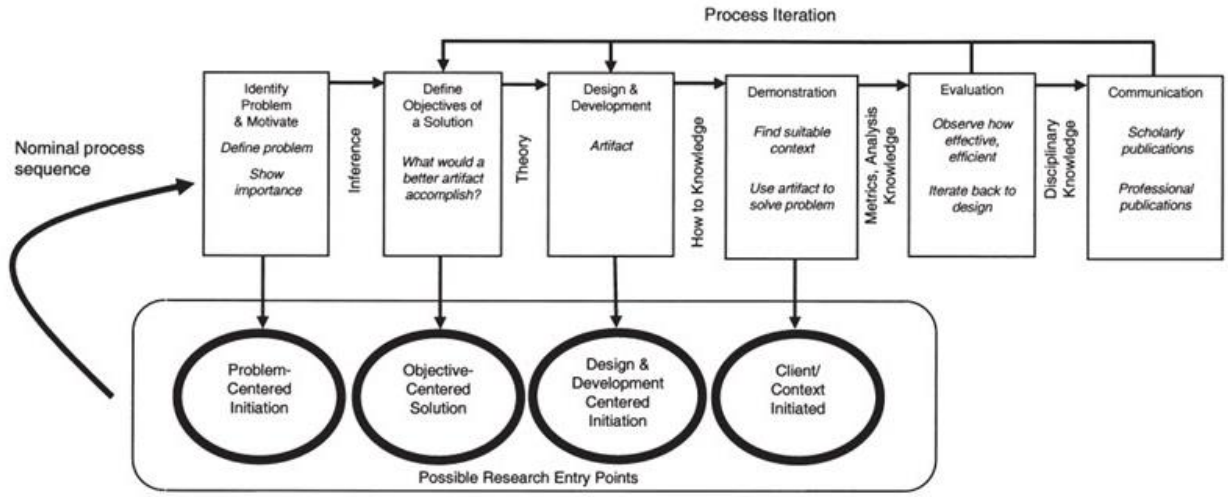

Figure 3: Peffers process model (Peffers, 2008)

The model is similar to other design science models, but of the scenario of this study there is no need for extra steps in the "Awareness of problem" or "Evaluation" process, as this will be decided by the project manager from the interview, while there is a need for more time in the "Development" phase because it is also being broken up into smaller phases. Phases are easy to go back to when something goes wrong.

Thus, the Vaishnavi Process Model will be used because it emphasises more on the detailed processes for generating design science knowledge and is easier to understand and follow.

1.8. Approach to project management and project plan

Only in the development phase of the Vaishnavi process model will an agile methedology be used to aid in the development process.

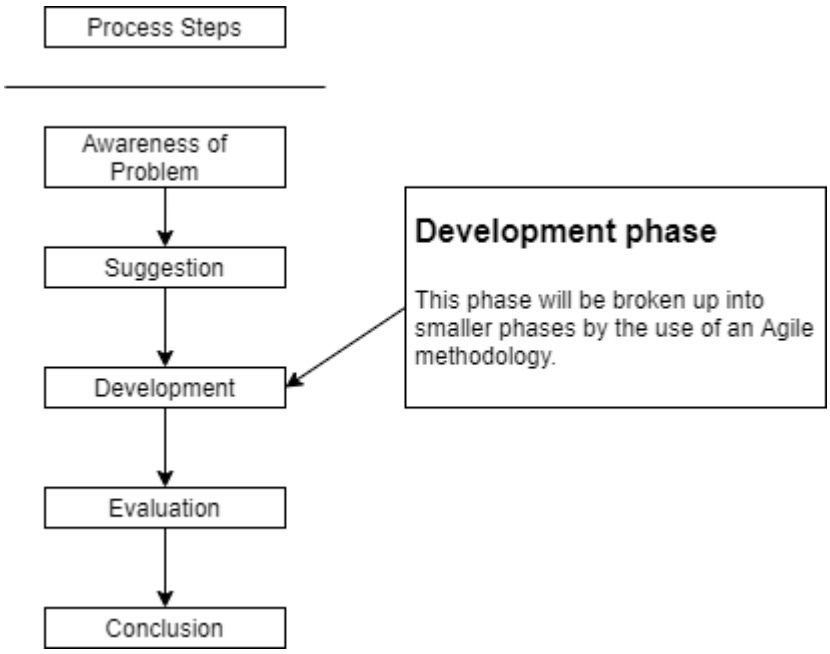

Figure 4: Where the Agile methodology will be applicable

1.8.1. Agile methodology

According to Kumar and Bhatia (2012), this methodology gives an iterative, flexible design and building process. It includes a set of processes for comprehensive projects in environments that are constantly changing.

Agile was designed to overcome the old waterfall way of programming, which caused a project to fail after years because of something that happened in the early stages of the project. An overview of this methodology is creating smaller phases of the project called sprints. Where it looks to deploy a draft in the first sprint and a piece of software in the first couple of months. Feedback is needed from the customer on a daily basis, to ensure that the project is on track.

The most common and popular example of this methodology includes SCRUM, Feature Driven Development (FDD), Dynamic Systems Development Method (DSDM) and Crystal (Ismail, 2019).

The project will be broken up into 2-week periods and at each start of the two weeks the project will undergo a sprint planning discussion where the backlog items will be prioritized, and some tasks will be placed back in the sprint backlog. According to Campbell (2020) this will make complex work transparent and easier to understand.

At the end of each sprint, every task should be finished and ready to be released. Each task will also undergo a "show me", "code review", "merge" and a "QA". This will reduce the risk of having bugs in the artefact because there is a user acceptance test layer.

1.8.2. Description of development platform, resources, and environments that will be used

The artefact for this study will be a web application. According to Paul Stanley Software (Stanley), there are several advantages to creating a web application. Users do not have to install an application because every computer has a browser. It is easy to update, and users have direct access to these updates.

For the user interface, Vue.JS will be used as a binding framework because It is easy to understand, small in terms of size, and flexible (Vivek, 2018), as well as HTML, JavaScript, and CSS. For the backend Visual Studio's Web API will be used and written in C#. The Database management system that will be used is SQL SERVER. The database and website will be hosted on Azure.

Factors that play a role in the environment are as follows:

1.8.3. Rigour, validity, and reliability in quantitative research

In this study rigour is the quality of being extremely careful while working on the artefact. "Qualitative research is frequently criticised for lacking scientific rigour with poor justification of the methods adopted, lack of transparency in the analytical procedures and the findings being merely a collection of personal opinions subject to researcher bias" (Noble & Smith, 2015). Rigour will be established by the project manager that will be interviewed. Their answers will determent what features need to be in the web application.

Validity is the appropriateness of the processes, tools, and data. Validity can be tested when the choice of methodology is only appropriate when it can answer the research question, the desired outcome is valid according to the research question, the sampling

of the data is appropriate, and conclusion and results are valid for the context and sample (Leung, 2015).

Reliability in this study refers to the replication of the results and processes. Then diverse paradigms are used in qualitative research the definition of reliability is demanding and epistemology is counterintuitive. Thus consistency is the essence of reliability for qualitative research (Leung, 2015).

1.9. Ethical considerations

According to Enago Acadamy (2020) ethical consideration includes:

(i) Validity

Specific research questions have to address the research design. The result must correlate with the conclusion and to the questions posed.

(ii) Voluntary participation and consent

No individual should feel that they have to participate in the study. This includes any type of deception or persuasion.

(iii) Sampling

An explanation is a need for why you want a particular group of participants and why some groups have been left out.

(iv) Confidentiality

Confidentiality needs to be respected, if any participant is at risk of harm, they need to be protected.

(v) Risk of harm

Everything in our power needs to be done to protect study participants. The risk to benefit ratio needs to be focused on.

(vi) Research Methods

Consideration of what is the right approach to the study.

1.10. Provisional chapter division

The study will include the following chapters:

(i) Chapter 1: Introduction

In this chapter the underlying problem will be introduced as well as the methodology and principles that is going to be used. The objectives will be stated, and development platforms will be noted.

(ii) Chapter 2: Research methodology

In this chapter the research paradigm that is applicable to the study will be explained. It will also elaborate on the design science and why it was chosen for the study.

(iii) Chapter 3: Literature review

Existing literature will be discussed in this chapter as well as key concepts of the study.

(iv) Chapter 4: Data Analysis

In this chapter data gathering techniques will be discussed and how the data will be analysed to improve the existing concept.

(v) Chapter 5: The artefact design

This chapter will be used to display the web application artefact.

(vi) Chapter 6: Conclusion

This chapter will conclude and give an overview of the study.

1.11. Summary

This project proposal serves as an introduction to the research of the paper. The problem for project managers that have more than one project, communicating important information for each project can be challenging especially the planning,

analysis, and implementation phases in the software development life cycle. Project developers that periodically look on their phones for messages can lower productivity and creativity.

The study will aim to develop a web application to improve communication in the industry. This web application should be developed according to the qualitative research done and if the requirements are not met then the application is of no use.

The objectives have been defined as well as what approach will be taken. The Vaishnavi process model will be followed to develop the application. An interview will be used to gather data on what information should display on the web application. Rigour, validity, and reliability will be considered when working on the artefact as well as ethical considerations when gathering data.

Chapter 2: Research Methodology

The goal of this study is to develop a web application that can be used to enhance communication between developers and management at a South African software development company. To reach the goal of this study, research on the different research methodologies has to be done.

According to Cambridge University (2015), research is a detailed study of a subject, but more specifically to reach a new understanding or to discover new information. This is described as a number of overlapping or similar activities that involve the search of information. Research is done by collecting data and documentation on a specific topic then analysing and interpreting the data or information. Research is conducted with the goals being: to evaluate the validity of an interpretive framework or hypothesis, to gather knowledge and share the findings in an appropriate manner and generate questions to be inquired further.

In this chapter, the different paradigms will firstly be discussed, followed by positioning and motivation of the chosen paradigm for this study. As the primary objective of this study is to develop a web application to improve communication in the industry, design science research was chosen to be the most applicable paradigm for this study. Design Science Research is discussed in-depth, as well as the qualitative data gathering techniques, and ethical considerations that need to be kept in mind.

2.1. Problem description and background

In the corporate world, businesses rely on effective communication to succeed. Developers lack the number of screens that they need to keep all their important tabs open. This makes it harder for important messages to reach developers and influences productivity and creativity (Schrader, 2018).

As a solution, an artefact has to be developed to assist with the effectiveness of communication in the industry.

2.2. Aims and objectives of project

This study proposes the development of a communication web application that can easily be viewed in an office by all employees to allow easy access to important communication regarding specific software development projects. Where the primary objective is to develop a web application for a South African software development company that allows for easy access to important communication relating to specific project.

2.3. Methodology literature review

2.1. Introduction

A research methodology is defined as the specific techniques or procedures that can be used to select, identify, analyse and process information or data on a specific topic (Duke & Mallette, 2011). The methodology section in a research paper, allows a reader to assess the overall reliability and validity of a study.

This following section will discuss how the data was analysed, as well as how the information and data is generated and collected. The literature review for this study includes research on what is functionality in needed in the artefact.

2.2. Paradigms

According to Sahifa (2017) a research paradigm can be defined as a research model or approach used to conduct research. This model or approach has to be verified by the research community as well as be in practice for hundreds of years to be considered a paradigm. Three paradigms that are common are interpretivism, design science and positivism (Vijay Vaishnavi, 2004). The research paradigms will be discussed in short in the section below.

Each paradigm can be broken up into four philosophical assumptions named Ontology, Epistemology, Methodology, and axiology (McGregor & Murnane, 2010). Ontology focuses on the reality and strives to understand the social world, just like the natural world. Epistemology focuses on objects and strives to study a situation or fact that

exists or happened, without disturbing or affecting that phenomena (Vosloo, 2014). Methodology focuses on the methods and how it is used to capture data. Axiology focuses on the values that are relevant to the study and what those values hold and why. (Vijay Vaishnavi, 2004).

The following table shows the philosophical assumption of the three research perspectives according to Vijay Vaishnavi (2004).

Table 1: Philosophical Assumption of Interpretive, Design and Positivist

Basic Belief	Research Perspective		
	Interpretive	Design	Positivist
Ontology	Socially constructed and Multiple realities.	Socio-technologically enabled. Contextually situated, Multiple alternative world-states.	A single reality, probabilistic, knowable.
Epistemology	Subjective that is knowledge and values emerge from the researcher-participant interaction.	Knowing through constructing. Objectively constrained construction within a context. Iterative circumscription reveals meaning.	Objective. Detached observer of truth. Dispassionate.
Methodology	Participation. qualitative, dialectical, and hermeneutical.	Developmental. Measure artefactual impacts on the composite system.	Observation. statistical, quantitative.
Axiology	Understanding. Description and situated.	Creation, Control, Progress(improvement), and understanding.	Truth. beautiful and universal. Prediction.

The next section in the paper will discuss the three common paradigms according to Vijay Vaishnavi (2004), followed by an in depth discussion of the chosen paradigm, Design Science Research.

2.2.1. The interpretivism paradigm

The interpretivism paradigm is there to understand and research the subjective world of human experience and emphasises the understanding of individuals and the interpretation of the world around them (Dean, 2018). Through a consistent manner, grounding theory is used to analyse and gather data, and researchers try to discover patterns in the data collected to understand a generated theory or phenomenon (Strauss & Corbin, 1990).

2.2.2. Design science paradigm

Design science as a paradigm is based on two major activities that are design, and investigation of the artefact (Wieringa, 2014). The design of the artefact is intended to interact with someone or something to solve a certain problem. Evaluation methods in design science are to develop prototypes of the artefact, interviews and field experiments (Ken Peffers, 2008).

2.2.3. Positivism paradigm

The positivism paradigm is based on the theory that to maximise the understanding of humanity is trough reason and observation (Ntgrty, 2016). According to this paradigm, the assumption is made that reality is independent from humanity. It focuses on getting facts through empirical qualitative analysis and methods and is based on solving everyday problems with the use of analysing statistics (Vosloo, 2014).

2.3. Positioning and motivation of the chosen paradigm

As the primary objective of this study is to develop a web application to improve communication in the industry, design science research was chosen to be the most applicable paradigm for this study. Researchers using design science use and artefact to solve a certain problem (Peffers, 2008), thus designing and investigating a web

application will be most effective in achieving the main objective of this study. Where other paradigms where they have different philosophies regarding that is knowledge, truth and understanding, design science research can create part or all of the phenomenon as opposed to naturally occurring (McGregor & Murnane, 2010).

A web application servers as a way of getting information easily and is accessible on any computer device that has an internet connection (Vivek, 2018). This will further increase the effectiveness of the artefact and achieve the objectives of this study.

Design science research was the most suitable paradigm and will be discussed in the next section of the paper.

2.4. Design Science Research methodology literature

According to Pello (2018) design science research is a new approach to research to reach a goal of creating a new reality, instead of making sense of an existing reality. Whereas Vijay Vaishnavi (2004) defines design science research as a set or "lens" of analytical and synthetic perspectives and techniques for conducting research in Information Systems. Design science research usually involves the development of a design theory or an artefact as well as finding a way to improve the current state of the way that it is being used, as well as researching existing knowledge (Ken Peffers, 2008).

Design science primarily focuses on two activities that can be used to understand the behaviour of certain aspects and improvement of Information Systems. These two activities that are focused on are: (1) the making of new knowledge with the use of the development of innovative artefacts and (2) analysing the artefacts for its usefulness and performance with abstraction and reflection (Peffers et al., 2006). Some artefacts in the process of design science include computer interfaces, algorithms, or system design methodologies.

The word design as defined by Vijay Vaishnavi (2004), is to invent something and bring it into being. Thus, design science has the intention to create something new that does not exist. If there is already a design out there with the same intentions as the one

being developed then the design is seen as *routine*, if it does not exist outside of the research, then it is seen as *innovative.*

This study is seen as routine, because there are existing knowledge for creating the artefact and there is no need for conducting research to fill the gap where there is a lack of knowledge (Vijay Vaishnavi, 2004).

Different Design Science research can follow different approaches and processes. An example is the use of either the Process Model developed by Peffers et al. (2006) or the Process Model developed by Vijay Vaishnavi (2004) to help with the guidance of doing Design Science Research. For research purposes, a study on both Process Models needs to be done, to conclude the most applicable to this study and will be discussed in-depth in the next section of the paper.

2.4.1. Conclusion

After researching both the Process Model developed by Vijay Vaishnavi (2004) and the Process Model developed by Peffers et al. (2006), the Vijay Vaishnavi (2004) Process Model was chosen because of the easier flow of phases and more time spent on the development phase. Due to the size of the research, there was no need for the additional phases that the Peffers et al. (2006) Process Model had to offer. Due to more time in the Development phase, the Vijay Vaishnavi (2004) Process Model also allowed the use of an Agile methodology in the Development phase. The Agile Methodology will be discussed later in the paper.

Following is the an in-depth discussion on the Process Model developed by Peffers et al. (2006) and on the Process Model developed by Vijay Vaishnavi (2004), as well as why the Vijay Vaishnavi (2004) Process Model was chosen for this study.

2.5. Reflection and Integration

In this section of the paper, the focus will be on design science research methodology that is used to achieve the aims and objectives of this study through the creation of an artefact.

Following is the process model developed by Peffers et al. (2006).

2.5.1. Peffers Process Model

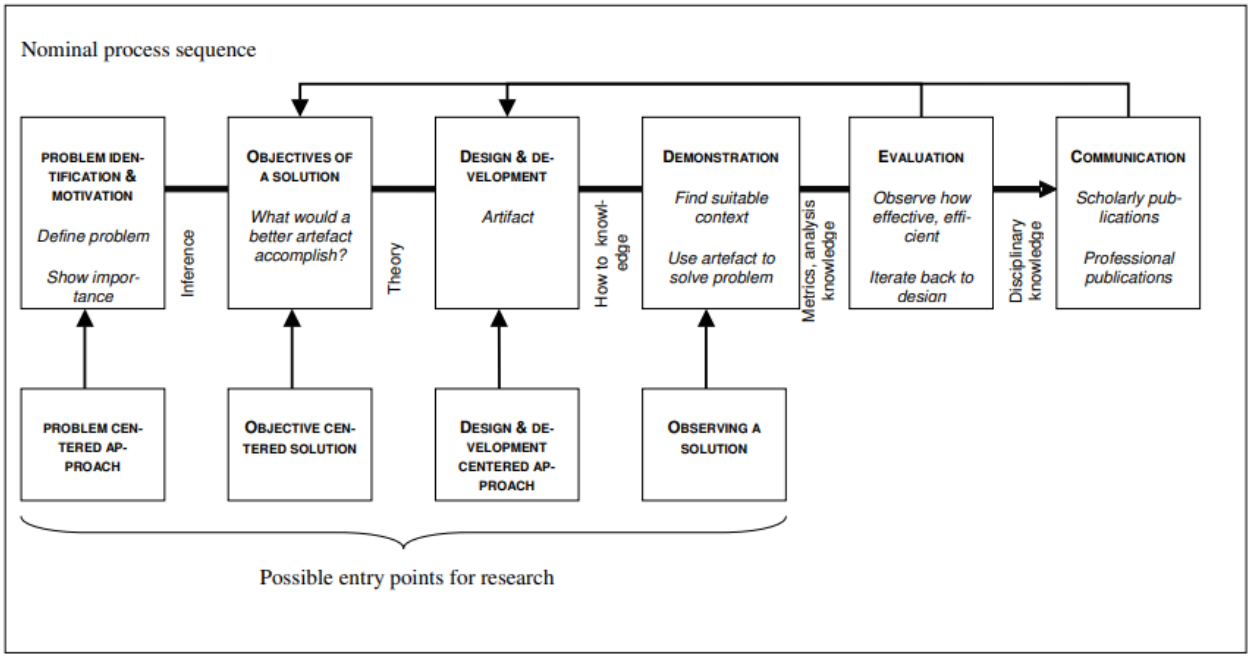

Figure 5: Peffers Design Science Research Proccess Model

This process model consists of six steps and will be discussed shortly in the following section of the paper.

(i) Problem identification and motivation

This is the recognition that there is a need for this process model in Information Systems and that there is a need for design science research to be done on this topic.

(ii) Objectives of a solution

This is the development of the objectives that is needed to be reached in the research, as well as a mental model for the Design Science Research output.

(iii) Design and Development

This is where an artefact solution is created. This includes the activity of determining the functionality that the artefact must have.

(iv) Demonstration

This is where the researcher has to demonstrate how the artefact can solve the given problem. This includes experimentation, case studies, simulations, or any other activity to show its effectiveness.

(v) Evaluation

This is the measurement on how well the artefact can solve the given problem. This is comparing the objectives given in the objectives of a solution phase to the functionality of the artefact.

(vi) Communication

This is the communication of the problem, how important the artefact is, and how effectively it can solve the problem.

2.5.2. Vaishnavi Process Model

In this section, a model of the overall process that is followed by design science will be discussed as described by Vijay Vaishnavi (2004).

Following is the Vijay Vaishnavi (2004) Process Model.

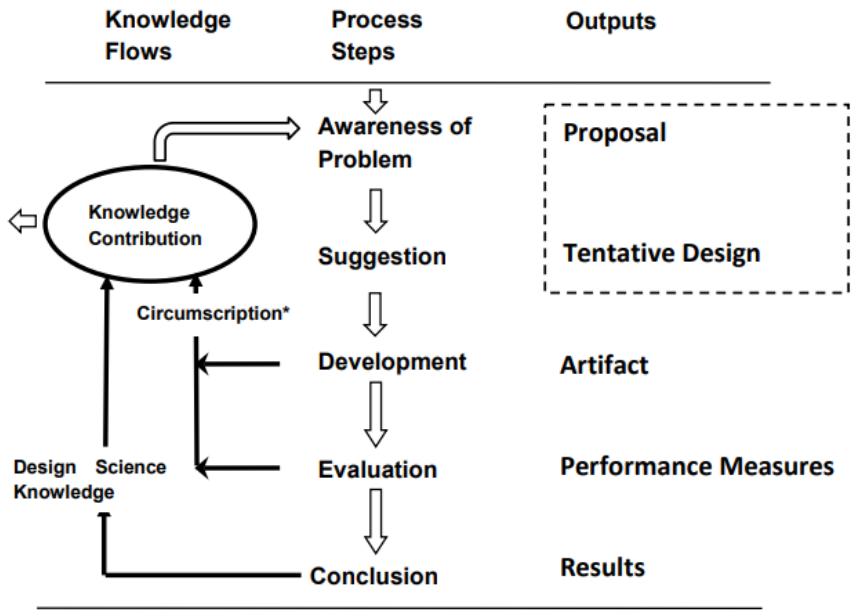

Figure 6: Vijay Vaishnavi Design Science Research Process Model

The Vaishnavi model is based on the process model developed by Takeda et al. (1990). Although there are similarities in the design process, activities in the different phases are not the same. The Vaishnavi process model also focuses more on the contribution of new knowledge. This process model consists of five steps and will be discussed shortly in the following section of the paper.

(i) Awareness of problem

According to Vijay Vaishnavi (2004), this phase can come from different sources and include identification of problems or new developments in the industry. Reading different articles on this field opens up the opportunity for new findings in other fields. Typically, the questions in this phase are focused on finding an approach to solve the problem, and not questions that can be answered through explanation.

Part of this phase is to become familiar with ways in which the final artefact can be evaluated to see if it had solved all of the objectives. The output of this phase is an informal or formal proposal for a new attempt on research.

In this study, the objective is to improve the communication between project managers and project developers, by having an easy way to access to important communication related information.

(ii) Suggestion

After the Awareness of problem phase is the suggestion phase. The central idea of this phase is creativity and new functionality based on the novel configurations from either existing or new elements. As part of the integral proposal, a Tentative Design and performance of that design is needed.

When the researcher is dissatisfied with the with the Tentative Design and considerable effort was put into it, the Proposal will be set aside. Thus, there are dotted lines over the Proposal and Tentative Design (as shown in Figure 1) for the connection between the Awareness of Problem phase and Suggestion phase.

In this study, an interview will be held with an experienced project manager from the industry. The Tentative Design will be made according to the project manager suggestions. This will form part of the requirement analysis.

(iii) Development

In this phase the Tentative Design is developed and implemented further. There are various ways to develop an artefact, from design theories (Lindner & Rodger, 2017) to instantiations, models, concepts or processes (Laurillard, 2013). The techniques will vary from one artefact to another. In some cases, a formal proof may need to be constructed to show correctness. For this study, a model will be made to achieve its objectives and get the desired outcome.

2.5.3 Agile Methodology

In the development phase, an Agile methodology will be followed to break the development phase into smaller pieces.

Agile was designed to overcome the old waterfall way of programming, by using the agile methodology, the prevention is made from having to start the whole project from the start because of something that happened in the Awareness of Problem phase (Kumar & Bhatia, 2012).

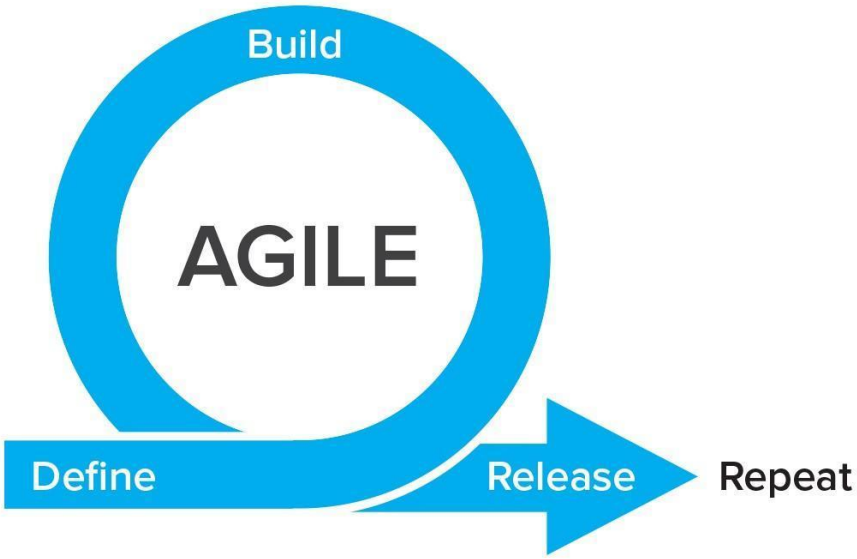

Figure 7: Agile Methodology (Roman, 2018)

In this Methodology the idea is to create smaller phases of the project called sprints. A sprint is a short period of time that is allocated for a small part of the project that helps focus only on the most important work that needs to be done (Kumar & Bhatia, 2012). As shown in Figure 2, you break every feature into three phases namely: Define, Build, and Release.

Define is where you take one feature that comes from the backlog of the project. A backlog is a list of features that still needs to be done. Unless told otherwise, the highest priority that will satisfy the customer will be picked to be done first (Roman, 2018).

Build is where you spend time on building the new feature. This usually takes the most time and can also be broken down into steps (Hoek, 2018). If the build is not successful, the developers need to come back to the phase to fix the bugs or change the whole feature.

Release is where you release the final feature into the live environment. Feedback is needed from the customer on a daily basis, to ensure that the project is on track and that the feature is what they wanted (Roman, 2018).

For this study, a web application will be designed according to the requirements given by the interview done in the Suggestion phase.

(iv) Evaluation

Once the development phase is complete, the artefact is evaluated according to the criteria that was created in the Awareness of Problem phase. In positivist research this is where the evaluation will result in either a contradiction or confirmation of the hypothesis by in design science research the results of the evaluation can be used to gain information and be used to improve the artefact (Vijay Vaishnavi, 2004).

Design science focuses on the utility of the artefact (Alan Hevner, 2004), but in this study it should also be considered to be evaluated for its fitness to survive and adapt within the industry environment as suggested by T. Grandon Gill (2013).

The results of the evaluation will either suggest a redesign of the artefact, therefor additional research needs to be done on why this artefact was not successful or move on the conclusion phase of the process model.

In this study, the web application will be evaluated by the suggestions made by the project manager that was interviewed in the suggestion phase. The feedback of the project manager will be crucial as they will share their expertise and experience, and insights to improve the artefact.

(v) Conclusion

This is the last step in the process model and the result is typically satisfaction of the artefact. This phase does not only revolve around the artefact but also the experience and knowledge that the researcher has gained. As part of the conclusion phase there is an arrow pointing out of the knowledge contribution as shown in Figure 1, that means that the artefact is going to contribute to the research area and is seen as complete.

In this study the artefact will contribute to the research area if it meets the requirements that was made in the suggestion phase as well as survive and adapt to the industry.

2.6. Research Objectives According to the Process Model

An objective is defined as something that you plan on doing or to achieve (Insights, 2019). Each Phase in the Process model has its own objectives. Following will be each phase along with its specified objectives.

(vi) Awareness of problem

- Gain knowledge of Design Science Research.
- Get a basic idea on what is expected of the artefact.

(vii) Suggestion

- Conduct an interview with a project manager that has experience in the industry.

- Use the information gathered to improve the design of the artefact.

(viii) Development

- Develop the web application according to the information gathered by the interview.
- Break the project up into small processes and divide into sprints.

(ix) Evaluation

- Evaluate the web application with the given requirements from the suggestion phase.
- Assure that the developed artefact can survive and adapt with the industry environment.

(x) Conclusion

- Report whether the artefact has achieved its main objective and that is to enhance communication between project managers and project developers in the industry.

2.7. Data gathering techniques

According to Lochrie et al. (2015), qualitative gathering techniques can yield revelatory, rich, and valuable data. As an example, a qualitative interview involves a conversation between a subject and the researcher that results in the understanding towards central themes such as accessibility to a certain feature.

Methods that can be used for qualitative data collection are:

(a) Individual interviews

This is the most widely used and trusted qualitative data collection method. This is the direct conversation between a researcher and a subject. The questions are designed to get the subjects knowledge or perspective on a certain topic, issue, or program.

(b) Qualitative surveys

This is used for more open-ended questions where the responded has to write their own opinions on a topic or issue. This can be done wither by giving out papers or online. Where the online surveys give a wider variety of people, for if the researcher wants to gather information around the world.

(c) Focus group discussions

A focus group discussion can be seen as a type of interview, but instead of having one individual, it is conducted with a group of people. The use of this is to see how people feel as a group, where a range of responses are available and discussed.

(d) Observations

This allows researchers to gather descriptive data by observing a subject and seeing its behaviour in a natural way. Observation only allows the researcher to be completely immersive and not participating in the activity and is only there to take notes. There are different ways to observe, such as taking videos or pictures.

2.7.1. Conclusion

The qualitative data gathering technique that will be used in this study is interviews, as it is considered to be the most applicable to get the most valuable data that is needed. The questions will focus gathering important features for the web application as well as getting input on the user interface design.

2.7.2. Ethical consideration in qualitative research

According to Roller (2015), there are certain ethical considerations to keep in mind when conducting an interview for this study.

- Voluntary consent from the participant.
- Give participants the option to stay anonymous.
- That the participant is allowed to give their own opinion at all times.

- Only interview a participant that is relevant to the study.

Along with the mentioned ethical considerations, a study leader and the ethics committee of NWU (North-West- University) has to approve the qualitative research done by this study.

2.8. Summary

The goal of this study is to develop a web application that can be used to enhance communication between developers and management at a South African software development company. In the corporate world, businesses rely on effective communication to succeed and plays a big role in day-to-day activities in the industry.

This study proposes the development of a communication web application that can easily be viewed in an office by all employees to allow easy access to important communication regarding specific software development projects

According to Vijay Vaishnavi (2004) there three paradigms that are most common are interpretivism, design science and positivism and each one of them have their own part in the research world, with all of the having different outcomes.

In design science there are different approaches and processes that can be followed. This paper discussed two process models namely: the Peffers et al. (2006) Process Model and the Vijay Vaishnavi (2004) Process model. Mainly due to the size of the research the Vijay Vaishnavi (2004) Process Model was chosen due to it being the easier Process model to follow and still be able to apply an Agile methodology in the Development phase.

Each phase in the Process Model has its own objectives and was discussed. The four qualitative data gathering techniques are individual interviews, qualitative surveys, focus group discussions and observation. Interviews was the technique that was the most applicable to this study and ethical considerations were discussed.

The next chapter of this study will be an in-depth discussion on existing literature as well as the key concepts of the study.

Chapter 3: Literature review

The goal of this study is to develop a web application that can be used to enhance communication between developers and management at a South African software development company. To reach the goal of this study, an evaluation to improve the communication using different communication methods and user interface design in a software development environment will be done.

According to Kim (2018) doing a literature review sharpens a researchers research focus, as it is the study of past work in order to understand how it relates to the research being done. By doing research on the different communication methods, it opens new possibilities and ideas on how the artefact will improve the communication in the company, as well as understanding the advantages and disadvantage of each communication method. Human-computer interaction helps with understanding of what the difference between a good and a bad system is, thus giving background on designing the artefact, and using past research on user experience.

This chapter addresses the key concepts of the study, namely the importance of good communication as well as the different communication methods used in the industry, followed by human-computer interaction and the importance of a good graphical user interface.

In the next section of the paper the problem description and background will be discussed.

3.1. Problem description and background

In the corporate world, businesses rely on effective communication to succeed. Developers lack the number of screens that they need to keep all their important tabs open. This makes it harder for important messages to reach developers and influences productivity and creativity (Schrader, 2018).

As a solution, an artefact must be developed to assist with the effectiveness of communication in the industry.

3.2. Aims and objectives of project

This study proposes the development of a communication web application that can easily be viewed in an office by all employees to allow easy access to important communication regarding specific software development projects. Where the primary objective is to develop a web application for a South African software development company that allows for easy access to important communication relating to specific project.

The theoretical objectives of this study are to identify the communication applications commonly used in industry, as well as gain knowledge of design science research to guide the development of an artefact. Therefore, in the next section of the paper a literature review will be done regarding different communication methods, followed by human-computer interaction.

3. Literature review

3.1. Introduction

According to Rowley and Slack (2004) a literature review is conducting a summary of a subject in a field that promotes the identification of distinct research questions. A literature review needs to gather information using different types of sources, such as books, professional journal articles and websites to find relevant information.

In this study the literature will be used to create a bigger view on the research as the background is explained and what paths was taken to reach the objective of this study. The literature review will ensure further insight in the research field (Knopf, 2006).

The goal of this chapter is to gain insight into the different ways in which communication can take place in the industry, as well as human-computer interaction to ensure that the web application is designed in the most user-friendly way.

In the next section of the study, the importance of good communication is discussed.

3.2. Importance of good communication

It is vital of the importance of good communication within a software development industry is often overlooked. When passing information about code, requirements and bugs it is crucial that information gets passed on correctly to the developers and to the company (Hellgren, 2018). To ensure that the stakeholders get their desired outcome, there needs to be a strong common understanding between the one that is making a request and the person that is completing the request. This common understanding can either lead to improving the project or someone spending time on a feature that is ultimately not what the users wanted, increasing the cost of the project (Dovleac, 2015).

For every scenario in a project, there is an optimal way of communicating. In the next section, the different methods of communicating are discussed.

3.3. Methods of communicating

There are various platforms used for communication within a work setting. According to (Hellgren, 2018), companies use email, instant messaging, wikis, chat systems, issue queues, social media, drawing or multimedia. Each communication method will be discussed in detail in the next section of the paper.

Email – A study exploring the amount of time a person spends reading and responding to emails, reports that an average person uses 28% of their work time reading, replying and writing emails (Hackeling, 2021). It is alarming to consider employees spending more than a quarter of their work time on emails, and in some cases, it involves personal emails as well. To avoid reading unnecessary emails, most companies advise their employees not to use their personal emails for anything work related (Niinimaki, 2011).

Instant messaging – Examples of instant messaging include WhatsApp, Skype, and Slack. Most companies only use one form of an instant messaging system (Leano, 2020), where some companies use more than one, this makes it exponentially harder for important information to reach the desired person (Dittrich & Giuffrida, 2011). The

main disadvantage of instant messaging systems is that people miss messages because they are not always on their phones or at their computers (Hellgren, 2018).

Wikis – Wikis are widely used by many organizations, they are a powerful way of communicating information to a group of people, but lack the functionality to notify that group of people, with important information (LeBar, 2017). Most wikis also do not have good version control for people to see who changes information and at what time (Hellgren, 2018). Information also need to be kept up to date, or else they do not benefit the project (Minocha et al., 2008).

Chat Systems – Chat applications like Rocket.chat, IRC and LiveAgent. Chat systems are great for sharing a lot of information to a group of people (Phpzag, 2021). They also do not overload the users when sharing information, like an Instant messaging system, because users can read the messages on their own time and concentrate on what is being said (Hellgren, 2018). A drawback of this form of communication is that you do not always want people to read the information on their own time, you want them to work on the feature or bug when you ask them to do so. They also lack notifications when new content is uploaded.

Issue queues – Examples of issue queues include Bugzilla, Jira, or Trello to exchange information about development. The problem with this is the lack of feedback, when someone completed a feature or bug, as they are just moved around to the specific topic with no explanation on why it is there (Zepel, 2021). This communication method brings a lot of value to the development process, this is useful as a side feature for this study and will definitely help solve the main objective (Bérczes et al., 2012).

Social media – Many social media platforms, for example Workplace by Facebook, have tools that allow companies to have their own channels for employees (Hellgren, 2018). Each employee has their own voice, and seeing employees work on problems in their own way. The downside of using this method is that the company pays for the brand. This making it more expensive than for example using an issue queue, and with social media platforms selling their user data for advertising, the security is not the best if you are discussing private business related issues (Blaszkiewicz, 2017).

Drawing – Drawing rich pictures is a great way to get employees to see things in new perspectives (Elin, 2012). The problem with this is combining verbal communication because you are not always in the same room or using another communication method (Cockburn, 2006). Same goes for making a PowerPoint or digital images. There is also poor version control as you cannot go back to older versions of the drawing (Hellgren, 2018).

Multimedia – methods include the use of audio recording or videos and is perfect for sharing media files to multiple people. This is beneficial for making training videos, so that you only have to explain something once, the problem is keeping the videos up to date, and people also find it harder to ask questions when they are watching a video compared to someone explain to them in person (Sarowardy, 2019).

3.3.1. Conclusion

There are more communication methods, but these are the most popular amongst software developing companies (Hellgren, 2018). All of them have their own advantages and disadvantages and can cause developers to spend time on things that are necessary for the development of the project, or waste time on something that does not add to the completion of the project (Storey et al., 2016).

3.4. Interruptions

According to Thorne (2020) it takes a person an average time of 25 minutes (to be exact, 23 minutes and 15 seconds) to return to a task after being interrupted. This can be frustrating to developers, and lost time can cost the company money. To be constantly interrupted, can cause a decrease in job satisfaction and lead to performance issues.

For this study, a method that would be most applicable is one that does not immediately interrupt a developer, while still being notified that there is important information that needs to be attended to. This will allow the developer or project manager to continue with what they are busy with and allow them to make it part of their routine to check their notifications.

3.5. Human-computer interaction (HCI)

According to Hinze-Hoare (2007) HCI is the way in which an artefact is designed to provide the best user experience. For one to achieve the best user experience, you need to understand the interaction between the system and the user (Terblanche, 2014). Human-computer interaction helps with understanding what the difference between a good and a bad system is, but it does not guarantee the development of a successful product (Blackwell, 2010).

Hinze-Hoare (2007) has produced ten rules that should be followed by all interface designers to guide them to create the best user experience. In the next section of the paper, the ten rules will be listed and explained in detail, with example of how it should be done in the study.

3.5.1. Simple and natural dialogue

According to Chen (2018), there should not be any sight of irrelevant information, Chen (2018) described it as having a "signal-to-noise" ratio. "Signal" being good because the user can easily find what they want to achieve in the system, whereas "noise" being bad because the system is giving the user irrelevant information that does not contribute to achieving their goal.

According to Terblanche (2014) every extra information on the screen competes for visibility. In a graphical-user-interface the "information" that is displayed can be anything from visual elements, text content, or animation (Chen, 2018). Not every user wants to achieve the same goal, making the signal-to-noise ratio change depending on the user.

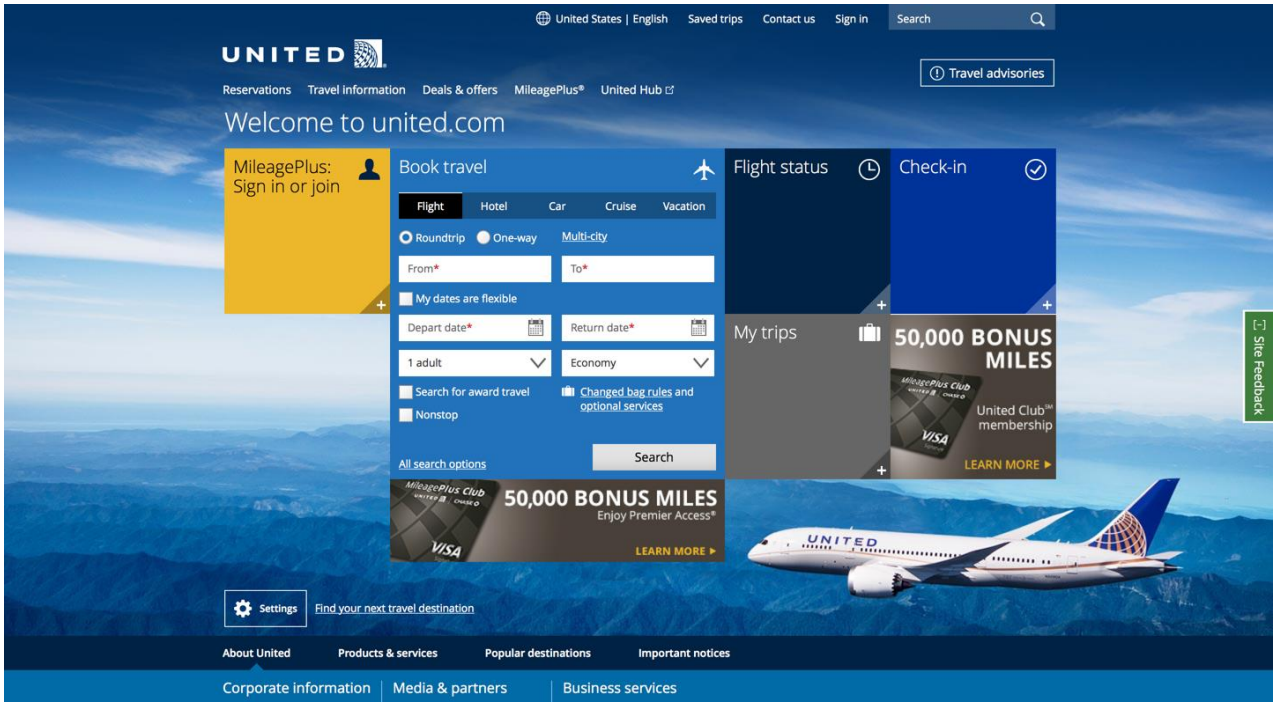

Figure 8: Simple and natural dialogue (Chen, 2018)

As shown in Figure 1, for a user that wants to book a new flight, the "Book travel" is a strong enough signal for them to easily find what they are looking for. Whereas a user that wants to see their flight status, the "Book travel" block is in the way because it is taking up most of the space (Chen, 2018).

3.5.2. Speak the users' language

The information that is available to the user should be expressed so that the user understands, and is familiar to the concepts, rather than what is understood by the system or the operator (Foundation, 2016).

Keep the language simple, and do not explain terms that people are unfamiliar with. For example a user that speak English as a second language will not necessarily understand an idiom and will need an explanation because they are unfamiliar with the concept (Foundation, 2016).

Figure 9: Speak the user's language (own example)

The language being used includes dialog boxes, menus, help files and instructions (Bridge, 2018). This can also include changing the language of the whole system, to give the user a better experience in their own language.

3.5.3. Minimize the users' memory load

According to Nielsen (2001), the importance here is to not have the user remember information from one page to the other to carry out tasks, and the user's information should be easily retrievable. By adding memory load, the users' capability to perform their main task gets reduced.

Ways in which memory load can be reduced are using a menu instead of commands, using default values, using visualization as external information, examples for the user and generic actions and rules (Nielsen, 2001).

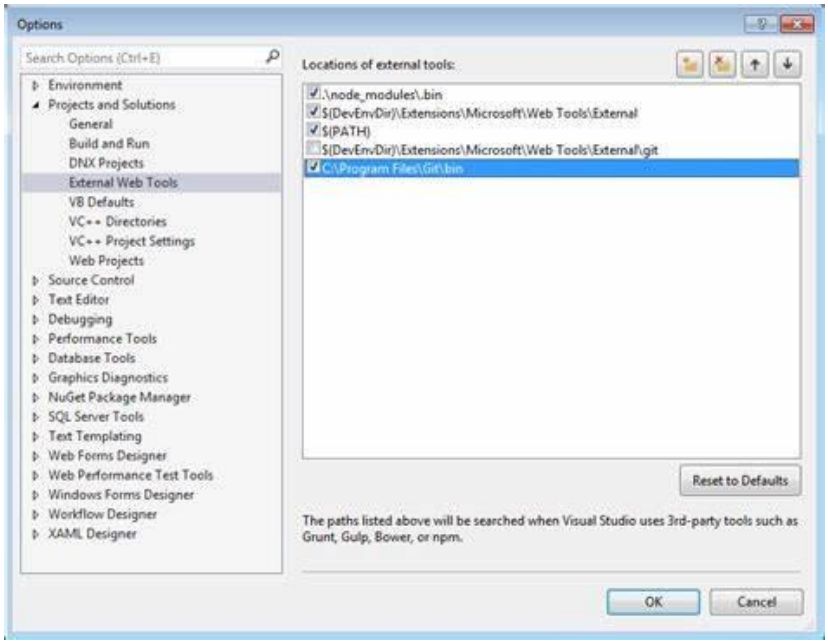

Figure 10: Minimize the users' memory load (UI, 2021)

As shown in Figure 3, the user can select options instead of running commands and default values are selected to minimize confusion. Another example is when an administrator clicks on one user profile, he does not want to remember the users name before he changes it. The information should already be on the page ready for the user to edit or confirm detail.

3.5.4 Consistency

This means that all generic buttons should be on the same place no matter where they occur in the system. According to Beckert and Beuster (2006), if there is a lack of consistency it can lead wrong interpretation of data or insufficient information given to the user. The system might provide a lack of information to determine the system state, or the user might interpret the output of the system wrongly.

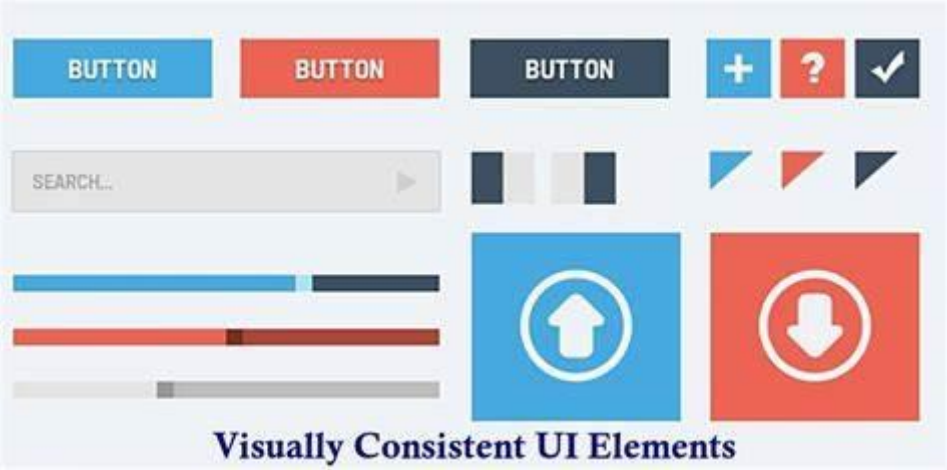

Figure 11: Consistency (Anić, 2015)

This is also applicable to "save", "delete", and "cancel" buttons that should always be on the bottom of the page as well as having the same colour all over the system, for example delete should always be red and save should always be green, this increases usability throughout the system (Anić, 2015).

3.5.5. Feedback

The user should always be aware of what is going on in the system, in a relevant and timely manner (Natoli, 2020). For example, when the user finished making changes and

clicks on "save", there should be a feedback notification stating that they did everything correctly and their changes have been successfully saved, or that their changes have been unsuccessful because the system is down.

According to Natoli (2020) the feedback given by the system should answer questions from these four categories:

- Future Status: What will happen next?
- Current Status: What is happening?
- Location: Where am I?
- Outcome and Result: What just happened?

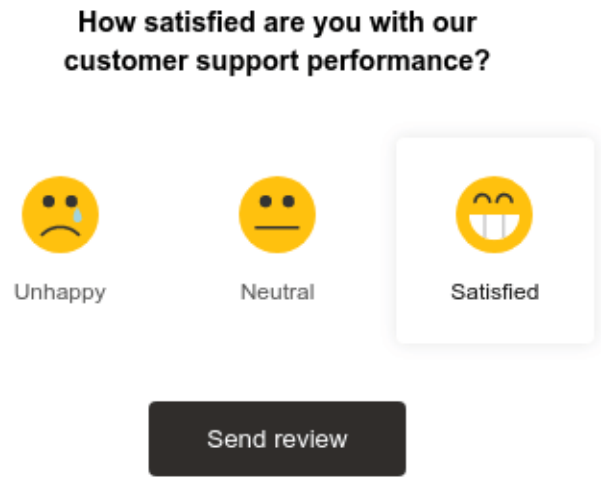

Figure 12: Feedback (Natoli, 2020)

Above all else, the feedback given by the system is there to provide answers to the questions that the human brain instinctively asks, such as "s the work saved?", "Am I finished?" and "What should I click?" (Natoli, 2020). This is also applicable to loaders that show that the page is still loading, or that the changes are being applied to the database.

3.5.6. Clearly marked exists

According to Blender (2015) errors can be easily made by a user, thus they need an easy way to return to the previous state without having to proceed with their mistake. The simplest way to display an error to a user, is to have a text box display over the process that is currently happening (Blackwell, 2010). This will inform the user that something went wrong, and they need to return to the previous state of the system.

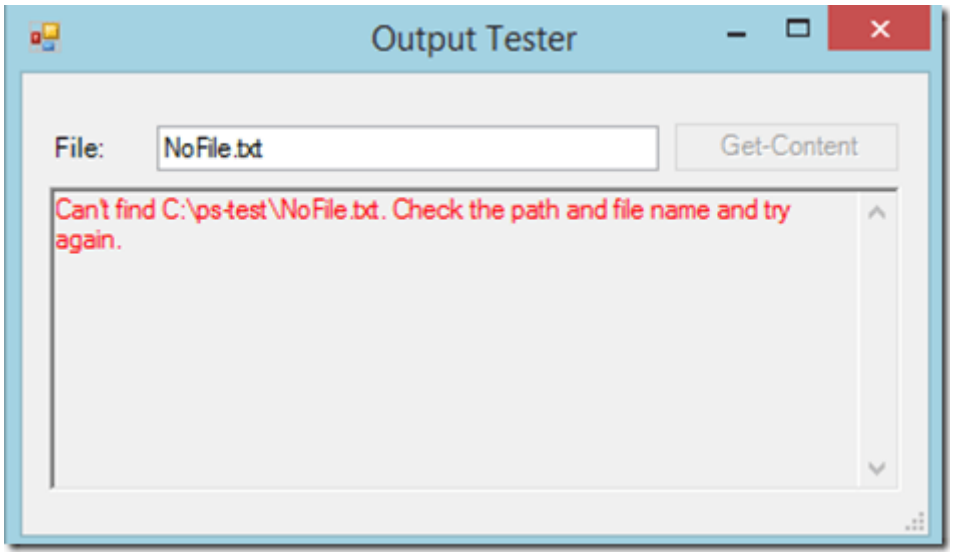

Figure 13: Clearly marked exists (Blender, 2015)

Another example of clearly marked exits other than the one displayed in Figure 6, is to give the user the option to return to the previous state. On every page, where you can edit or add data, there should be a "cancel" or "reset" button, that takes you back to the previous state. Consistency also plays a role, as exists must be on every page at the same place, so that the user always knows how to exit the page (Blackwell, 2010).

3.5.7. Shortcuts

According to Keerti (2020), shortcuts is used to speed up the interaction with the system by a user. This can be done by implementing a menu, using icons to represent a word, extra buttons or windows.

By adding a limited number of options to the menu, when the user selects the menu, it opens a sub-menu that gives further information. Menu-driven user interface helps with

the process of having to continue with the main page to reach your goal, but rather skipping to the desired goal (Keerti, 2020).

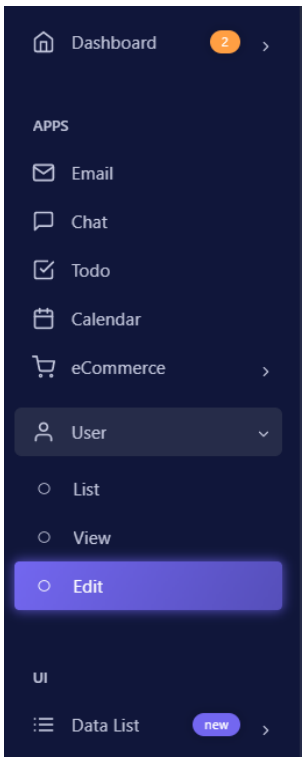

Figure 14: Shortcuts (own example)

As shown in Figure 7, there are also different menu levels, such as "List" users, "view" users, and "Edit" users. This makes it easier for experienced user to get to their desired outcome faster and gives the user insight on what are other outcomes of that main menu (Ngai, 2017).

3.5.8. Good error messages

Error messages should be displayed in plain language for the user to understand, and user-friendly error messages should answer the "what?", "why?" and "how?" (Gregory, 2019):

- What is the problem?
- Why did the problem occur?
- How do I solve the problem?

According to Gregory (2019), error messages need to be:

1. Specific to the user's task.
2. Let the users think that the system thinks like a human.
3. The possibility for humour in the situation.
4. Do not make users work for their desired outcome.
5. Have a useful "page not found" page.

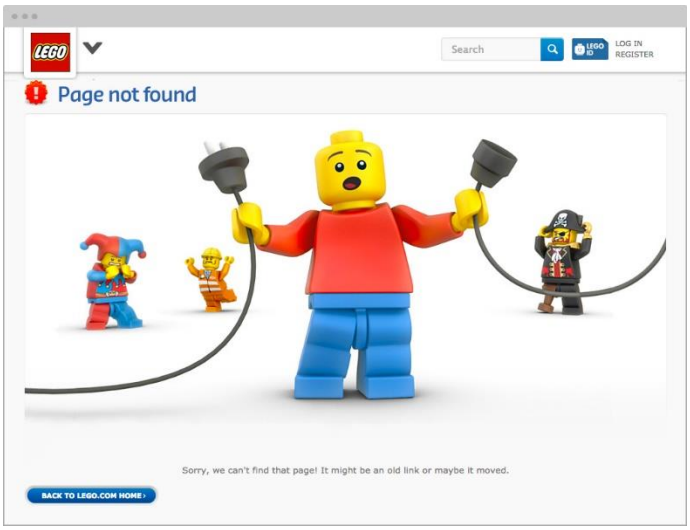

Figure 15: Good error messages (Gregory, 2019)

This also falls under consistency and feedback, as this should always show up at the same place, when the user did something wrong (Beckert & Beuster, 2006).

3.5.9. Prevent Errors

According to Continelli (2017), companies that rely on their systems to function all of the time, an error in the system can lead to financial loss, and the main cause of system failure is human error.

Human error can be prevented by carefully designing what the user has access to. This can be done by setting the user permissions and having them see and edit only allowing them the data that is relevant (Laubheimer, 2015). Users do not realize when

they are about to do something that can trigger the system to fail, thus giving them a preview of the results can lower the chances of error (Laubheimer, 2015).

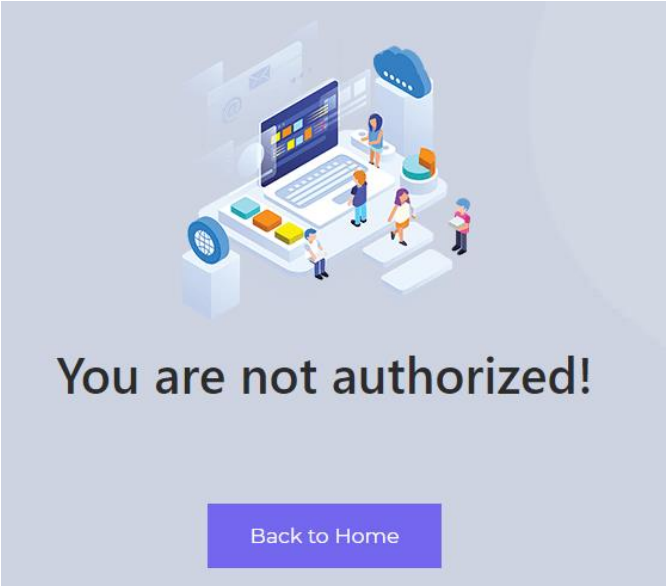

Figure 16: Prevent Errors (own example)

As shown in Figure 9, bugs do occur, and users get access to things that they should have access to (Laubheimer, 2015). This can be prevented by setting up the backend to look at the users' permissions and when the user does not have access to the page it redirects to the page shown in Figure 9.

3.5.10. Help and documentation

According to Trica (2019), if your system speaks for itself, it can be used without documentation, but if the users need help with anything in the system, it can be easy to allocate. There should also be documentation for the users and developers, this can impact the further development of the project as well as give users background of the system.

Included in the documentation for developers, there should be:

- Server Environments
- Business rules
- Database files

- Trouble shooting
- Application installation
- Code

Whereas the user documentation should be focused on the users' tasks and the steps to achieving specific solutions (Trica, 2019).

Figure 17: Help and documentation (own example)

3.6. HCI Conclusion

According to Fawcett (2021), it is important not to reinvent the wheel, but still use your own innovation. Developers have the tendency to transfer old interfaces to well-designed systems, and to prevent that a design that has set standards, prove to be more intuitive and have all human-computer interaction set in place (Fawcett, 2021). For this study, all human-computer interaction rules will be followed to improve on user experience.

The next section of the paper will be the summary of this chapter.

3.7. Summary

To reach the goal of this study, an evaluation to improve the communication using different communication methods and user interface design in a software development environment will be done.

The theoretical objectives of this study are to identify the communication applications commonly used in industry, as well as gain knowledge of design science research to guide the development of an artefact. By doing research on the different

communication methods, it opens new possibilities and ideas on how the artefact will improve the communication in the company, as well as understanding the advantages and disadvantage of each communication method. Human-computer interaction helps with understanding of what the difference between a good and a bad system is, thus giving background on designing the artefact, and using past research of user experience.

According to (Hellgren, 2018), companies use email, instant messaging, wikis, chat systems, issue queues, social media, drawing or multimedia. In this chapter each method was discussed in depth.

For this study, a method that would be most applicable is one that does not immediately interrupt a developer, while still being notified that there is important information that needs to be attended to. This will allow the developer or project manager to continue with what they are busy with and allow them to make it part of their routine to check their notifications.

Human-computer interaction helps with understanding what the difference between a good and a bad system is, but it does not guarantee the development of a successful product (Blackwell, 2010). All human-computer interaction rules will be followed to improve on user experience.

The next chapter in this study will be the empirical study and will cover the data gathering techniques used to analyse and improve the existing concept.

Chapter 4: Data Gathering and Analysis

The goal of this study is to develop a web application that can be used to enhance communication between developers and management at a South African software development company. As discussed in Chapter 2, this study follows the Vijay Vaishnavi (2004) process model, this chapter will focus on the "Suggestion" phase. The artefact needs to be built according to what the end user expects, this phase of the study is there to define the requirements properly and do an analysis on what is intended for the artefact (Softwaretestinghelp, 2021).

According to Valenzuela and Shrivastava (2002) the reason behind conducting an interview is to get a better understanding and insight on how to design the artefact. An interview was done with an experienced project manager from the industry, as part of the analysis that is required to design the artefact. The data analysis technique that was used for this study is open coding. Open coding is the first step in gradually making sense of data, the technique to open coding is to go through the data collected line-by-line and generate as many codes as possible and ultimately putting everything together (Utsc, 2020).

This chapter will firstly give background of the participant, followed by the interview questions. The section that follows will provide the feedback from the interview. An analysis of the feedback obtained is discussed in the section that follows. The chapter will end with a conclusion.

4.1. Problem description and background

In the corporate world, businesses rely on effective communication to succeed. Developers use their screens to communicate and to develop, it often happens that developers lack the number of screens that they need to keep all their important tabs open. This makes it harder for important messages to reach developers and influences productivity and creativity (Schrader, 2018).

As a solution, an artefact has to be developed to assist with the effectiveness of communication in the industry.

4.2. Aims and objectives of project

This study proposes the development of a communication web application that can easily be viewed in an office by all employees to allow easy access to important communication regarding specific software development projects. Where the primary objective is to develop a web application for a South African software development company that allows for easy access to important communication relating to specific project.

The type of interview used for this study is a semi-structured interview. A semi-structured interview is a combination between an unstructured interview and a structure interview, a researcher will ask questions from a list of questions, but after receiving the answer continue to have a deeper and more in detail conversation with the respondent (Bhasin, 2019). The interview was done in person and notes were made during the interview and is discussed later in the chapter.

After the interview open coding will be used as a data analysis technique to sort out important points and group them together (Utsc, 2020). By grouping the points together, you answer the following questions: "What is the respondent trying to say?", "What does it mean?" and "How is it said?". Open coding is used to extract the most important information out of the gathered data (Khandkar, 2009).

4.3. Data Analysis

According to Seers (2012) qualitative research uses a rigorous and systematic approach to answer questions on what people feel or think about something. This can address why something is what it is, or why something happened. Qualitative data takes the form of text or words, for example an interview.

Qualitative data analysis is making sense of the data gathered from the interview that was conducted (Caudle, 2004). The Analysis makes important information to the study clearer.

4.4. Participant

The participant that is was selected to participate is a specialist in project management and has experience in working in the industry. The feedback that is going to be obtained will benefit towards the design and layout of the artefact, as the participant has developed, designed, and managed various artefacts that are similar in the ways of client's expectations and needs. This participant was selected because their daily tasks include streamlining communication across their team, which contribute towards achieving the goal of this study. Furthermore, as project managers are superior in understanding an artefact as a whole, focusing on quality, cost and schedule, this feedback will contribute towards the design and development of the artefact (DiStasi, 2020).

4.5. Interview Questions

Table 4.5.1 below contains interview questions that was asked in order to gather the necessary data needed for analysis. Different sources were used to set up the needed questions.

Table 4.5.1: Interview questions

Number	Question
1.	What is the overall purpose of the artefact? (McNamara, 2019)
2.	What problem will be solved by the Software? (Tripathi, 2017)
3.	Are there other products or tools that we can, should, or need to integrate with? (Brockett, 2020)
4.	What features are most important to the target audience? (Tripathi, 2017)
5.	What value are we providing to users? (Brockett, 2020)
6.	What does success look like at each stage of the process? (Kumulos, 2015)
7.	What is the underlying assumptions? (Kumulos, 2015)

The questions in table 4.5.1. are the basic questions that are asked in such an interview, the last question is there to get information on what happens after the study. These questions need to be adapted to fulfil the purpose of the study and for the data analysis to be as accurate as possible. The questions that was adapted are shown in the table below, as well as why the question were asked for this study.

Table 4.5.2: Adapted interview questions

Number	Question from source	Question adapted for the study	Why this question?
1.	What is the overall purpose of the artefact? (McNamara, 2019)	What should the web application regarding communication accomplish at a software company?	This question will ensure that the artefact will indeed solve the problem of this study.
2.	What problem will be solved by the software? (Tripathi, 2017)	What problems will the web application solve at a software company?	This question will give feedback on how successful the artefact will be.
3.	Are there other products or tools that we can, should, or need to integrate with? (Brockett, 2020)	What other products or tools can, should, or need to integrate into the web application?	One of the goals of the study was to collect data on existing applications and adapt accordingly.
4.	What features are most important to the target audience? (Tripathi, 2017)	What features are the most important to add in the web application to improve communication?	This question will give feedback on what features are crucial to the

			artefact's success.
5.	What value are we providing to users? (Brockett, 2020)	What value are we adding to the company?	This question will give feedback on if the company will benefit from using the artefact.
6.	What does success look like at each stage of the process? (Kumulos, 2015)	At each stage of development, what do you see as success?	This question will give feedback on what the users expect at the end of the artefact.
7.	What is the underlying assumptions? (Kumulos, 2015)	What are the underlying assumptions when developing the web application?	This question will give feedback on how to approach the development.

The feedback from the interview will be represented in the next section of the study.

4.6. Interview response

4.6.1. What should the web application regarding communication accomplish at a software company?

- The web application should enhance the communication between management and developers at the company, the web application should be able to assist in the effectiveness of communication.
- It should be easy enough to access important information regarding communication between employees, the artefact should focus on user friendliness.

- The web application has to let the developers know when the plans of the project has changed. The web application needs to keep up, and constantly be updated by the project manager of developer.
- The web application should send notifications to remind you of something important.
- In general, it should feel that you put less effort into communicating with your employees and put more effort into working on your project.

4.6.2. What problems will the web application solve at a software company?

- Make it easier for important messages to reach the team, including project manager and developers.
- Making developers more productive and creative as they do not have to look at their phones periodically.
- Project managers have more freedom and can handle more than one project with ease.
- Developers have less tabs open while they work, as only one is needed and they can switch between programs easier.

4.6.3. What other products or tools can, should, or need to integrate into the web application?

- As the company is already using Slack as their main communication application, it should be integrated into the web application in a way.
- WhatsApp is also an application that is generally used to communicate when employees are not at their computers, especially after hours.
- Discord is a good Voice over Internet Protocol and can be very useful when having brief meetings.

- Trello can be used to organize the companies sprints and communicate on how each project is doing.

4.6.4. What features are the most important to add in the web application to improve communication?

- Issue queues, to exchange information about development, to give feedback as a project manager and developer.
- Use existing or create a chat system, such as Slack, Discord or WhatsApp.
- There should also be a calendar, to make it easier to organize meetings between employees and have a general idea of what is going on in the company.
- There should be a way for everyone to see with what other employees are busy with, and if they are too busy to talk to.
- A dashboard to see only the most important information at first glance.

4.6.5. What value are we adding to the company?

- Not immediately interrupting an employee, but still notify that something important is waiting for their attention.
- Create a more relaxed environment, while still maintaining order in the company.
- Easy access to the desired communication in the company and less miscommunication.
- More effective communication between employees, this leads to less time wasted, better quality of work and more money being made.

4.4.6. At each stage of development, what do you see as success?

- As a user, the end product is important. It should be bug free, easy to use and learn. It should also look formal.

- As a project manager, each sprint should be finished on time, bugs should be to a minimum. If this is not achieved, a different approach should be taken to improve on the quality of the project.

- Propper testing should be in place, this should include unit testing and user acceptance testing.

- At the end documentation should be in place for users.

4.6.7. What are the underlying assumptions when developing the web application?

- The users' experience is always first, and the changes should be made to benefit them.

- There should always be a preview of the work that has been done, this will happen after each sprint.

- It is sometimes better to use an off the shelf product than to make your own, it is usually cheaper.

- Do not waste time or money on creating functionality that do not benefit your project.

4.7. Analysis of data obtained from data Analysis

The data analysis technique that was used for this study is open coding, more specifically line-by-line coding, which is analysing the data line by line (Khandkar, 2009). Open coding is the qualitative data analysis technique for creating categories that order data according to their similarities and differences Khandkar (2009). Line-by-line coding is important for building different concepts out of a small-scale data set, making it perfect for this study.

When the analysis of the qualitative data was done, meaning units were extracted from the transcribed interview texts, then condensed into smaller meaning units, this relates to an assigned code and form part of the category. Each question was broken up into

meaning units and examples of the interviewee response was given of that meaning unit.

Feedback obtained for question 1 is analysed in table 4.5.1 below.

Table 4.7.1: Question 1 feedback

1. What should the web application regarding communication accomplish at a software company?	
Meaning unit	**Interviewee response**
Improve communication	"The web application should enhance the communication between management and developers at the company"
	"It should feel that you put less effort into communicating with your employees."
Update user about important information	"The web application has to let us know when the plans of the project has changed."
	"The web application should send notifications to remind you of something important."

As seen in Table 4.7.1 above, the artefact should focus on improving communication while putting less effort into communicating with employees. The user should also be getting updates on important information on an efficient manner.

The feedback obtained for question 2 is analysed in table 4.5.2 below.

Table 4.7.2: Question 2 feedback

2. What problems will the web application solve at a software company?	
Meaning unit	**Interviewee response**

More productivity	"Making developers more productive and creative as they do not have to look at their phones periodically."
	"Project managers have more freedom and can handle more than one project with ease."
More flexibility	"Make it easier for important messages to reach the team, including project manager and developers."
	"Developers have less tabs open while they work, as only one is needed and they can switch between programs easier"

As seen in Table 4.7.2 above, while using the artefact the users should be more productive and have more flexibility as they will not have so many tabs open at a time.

The feedback obtained for question 3 is analysed in table 4.5.3 below.

Table 4.7.3: Question 3 feedback

3. What other products or tools can, should, or need to integrate into the web application?	
Meaning unit	**Interviewee response**
Text messages	"As the company is already using Slack as their main communication application"
	"WhatsApp is also an application that is generally used to communicate when employees are not at their computers"
Project related	"Discord is a good Voice over Internet

	Protocol"
	"Trello can be used to organize the companies sprints and communicate on how each project is doing"

As seen in Table 4.7.3 above, the artefact should focus not only on communication between employees, but also focus on communicating the project details to the user.

The feedback obtained for question 4 is analysed in table 4.5.4 below.

Table 4.7.4: Question 4 feedback

4. What features are the most important to add in the web application to improve communication?	
Meaning unit	**Interviewee response**
Quick review	"There should also be a calendar, to make it easier to organize meetings between employees and have a general idea of what is going on in the company."
	"There should be a way for everyone to see with what other employees are busy with, and if they are too busy to talk to."
Development related	"Issue queues, to exchange information about development, to give feedback as a project manager and developer"
	"There should also be a calendar, to make it easier to organize meetings between employees and have a general idea of

	what is going on in the company."

As seen in Table 4.7.4 above, the artefact should be designed to have a quick way of viewing important information, for example a calendar feature and a way to view all employees to see if they are busy. The artefact should also focus on features that benefit the project that they are working on, for example issue queues.

The feedback obtained for question 5 is analysed in table 4.5.5 below.

Table 4.7.5: Question 5 feedback

5. What value are we adding to the company?	
Meaning unit	**Interviewee response**
Relaxed environment	"Not immediately interrupting an employee, but still notify that something important is waiting for their attention."
	"Create a more relaxed environment, while still maintaining order in the company."
Less miscommunication	"Easy access to the desired communication in the company and less miscommunication."
	"More effective communication between employees, this leads to less time wasted, better quality of work and more money being made."

As seen in Table 4.7.5 above, the two most important values that the artefact will bring into the company is creating a more relaxed environment while creating less miscommunication between employees.

The feedback obtained for question 6 is analysed in table 4.7.6 below.

Table 4.7.6: Question 6 feedback

6. At each stage of development, what do you see as success?	
Meaning unit	**Interviewee response**
User Experience	"As a user, the end product is important."
	"At the end documentation should be in place for users."
Project integrity	"Propper testing should be in place, this should include unit testing and user acceptance testing."
	"Each sprint should be finished on time, bugs should be to a minimum"

As seen in Table 4.7.6 above, success is having a user that is satisfied with the artefact, as well as having documentation for the user to follow. Having a project that is bug free while finishing on time is also seen as a success.

The feedback obtained for question 7 is analysed in table 4.5.7 below.

Table 4.7.7: Question 7 feedback

7. What are the underlying assumptions when developing the web application?	
Meaning unit	**Interviewee response**
Users first	The users' experience is always first, and the changes should be made to benefit them.

	There should always be a preview of the work that has been done, this will happen after each sprint.
Resource management	It is sometimes better to use an off the shelf product than to make your own, it is usually cheaper.
	Do not waste time or money on creating functionality that do not benefit your project.

As seen in Table 4.7.7 above, the two common underlying assumptions are putting the user first and making sure that they get what they want while spending the right amount of resources to achieve the end goal.

4.8. Report on findings

After the data analysis the most important requirements and specifications was identified and is shown in Table 5.1 below.

Table 4.8.1: Most important requirements and specifications

Most important requirements and specifications	
Number	**Requirement or specification**
1.	Easy Communication method.
2.	Improved productivity.
3.	Artefact should focus on communication between employees and communication about the project.
4.	Create a relaxed environment.

5.	The user experience comes first.

As shown in Table 4.8.1 above, the conclusion is that the artefact should improve both communication and productivity in the company. The artefact should focus not only on communication between employees, but also communicate the information about the project. The artefact should create a more relaxed environment in the company, while making it easier for the users to interact with the communication aspect that is required in the industry.

5. Conclusion

Qualitative data analysis is making sense of the data gathered from the interview that was conducted (Caudle, 2004). The Analysis makes important information to the study clearer.

The participant that was interviewed in this study is a specialist in project management and has experience in working in the industry. The feedback that was obtained benefited the design and layout of the artefact.

The data analysis technique that was used for this study is open coding, more specifically line-by-line coding, which is analysing the data line by line (Khandkar, 2009). Open coding is the qualitative data analysis technique for creating categories that order data according to their similarities and differences Khandkar (2009).

After the data analysis the most important requirements and specifications was identified and is shown. The conclusion is that the artefact should improve both communication and productivity in the company.

In the next chapter the artefact is designed and developed according to the finding of the data analysis.

Chapter 5: Artefact Design

The goal of this study is to develop a web application that can be used to enhance communication between developers and management at a South African software development company. As discussed in Chapter 2, this study follows the Vijay Vaishnavi (2004) process model, this chapter will focus on the "Development" phase. This chapter is the end of the initial section of the process model and the beginning of production.

5.1. Problem description and background

In the corporate world, businesses rely on effective communication to succeed. Developers use their screens to communicate and to develop, it often happens that developers lack the number of screens that they need to keep all their important tabs open. This makes it harder for important messages to reach developers and influences productivity and creativity (Schrader, 2018).

As a solution, an artefact has to be developed to assist with the effectiveness of communication in the industry.

5.2. Aims and objectives of project

This study proposes the development of a communication web application that can easily be viewed in an office by all employees to allow easy access to important communication regarding specific software development projects. Where the primary objective is to develop a web application for a South African software development company that allows for easy access to important communication relating to specific project.

The focus of this chapter is the development phase of the Vijay Vaishnavi (2004) process model and give a visual explain on how each of the requirements or specification is implemented with the use of screenshots and explaining some of the features that was added and how to use them.

5.3. The Artefact Design

5.3.1. Summary of feedback

The design of the artefact has to satisfy the requirements as set out in Chapter 4, the suggestion phase. Along with the requirements and specifications, the artefact also followed the human-computer interaction rules to provide the best user experience as discussed in Chapter 3 of this study.

The conclusion was that the artefact should improve both communication and productivity in the company. To achieve this the artefact should not only focus on communication between employees, but also communicate the information about the project. The artefact should create a more relaxed environment in the company, while making it easier for the users to interact with the communication aspect that is required in the industry.

Table 5.1. below shows the requirements or specifications and how it will be solved with the use of the built artefact.

1. Table 5.1: Most important requirements and specifications

Most important requirements and specifications		
#	**Requirement or specification**	**How it is solved in the artefact**
1.	Easy Communication method.	By combining different methods of communication as discussed in Chapter 2 of this study. For the Artefact the communication methods that was focused on was instant messages and Issue queues. For this study a new "Chat" feature was developed, this is to satisfy the need for an instant messaging feature. There was also a new "Drag and drop" feature developed where users can add items to a "To Do" list and move the item to either "Doing" or

		"Done", this was added to satisfy the need for an Issue queues feature.
2.	Improved productivity.	For a project overview, a member of a team will be able to see an overview of their team under a feature named "My Team". The feature will also provide important information on their team such as employee numbers, member status, member name and surname, member email, what the member is busy with and when last they were online. This will satisfy the need for improving productivity as a team as they are always aware of what they whole team is busy with.
3.	Artefact should focus on communication between employees and communication about the project.	Not only can users communicate with each other, but they can also get the necessary information about their project. For this artefact, an "Activities" feature was added. The Activities feature provides information on the backlog of the project, this includes the name, category, importance, and the status of the activity. Each activity can be edited at any moment as well as a bulk action to either archive or delete the actions, this will also improve productivity as less time is spent on the actual artefact and more time on the project. An analytics page is also added to the artefact to give information on the overall project, this includes "Sales Stats", "Activity Timeline"

		and "Project Timeline". This will provide a more long-term plan for the project.
4.	Create a relaxed environment.	A new calendar feature was developed for the artefact. The calendar can be viewed as either "Monthly", "Weekly" or "Yearly". This creates a more flexible way of planning the project and everyone in the team can contribute to events. The team can also tag each event with "Business", "Work", "Personal" or "None". They can also add a "URL" to an event, this can include a "Zoom" meeting link, "YouTube" link or any important link needed for the event. This will improve the structure of the project and make members of the team more relaxed knowing that every event is planned out.
5.	The user experience comes first.	By using pre-emptive dialog, users will make minimal errors when working with the artefact. This includes the ten human-computer interaction rules discussed in Chapter 3. This includes having validation on each input of the user, having loading elements if the user has to wait for data to be retrieved as well as having the ability to change something that they saved incorrectly.

5.3.2. Artefact design

The design of the artefact is based on the most important requirements and specifications shown in Table 4.1. The next section of the study will visually explain how each of the requirements or specification was implemented with the use of screenshots and explaining some of the features that was added and how to use them.

5.3.2.1. Easy Communication method

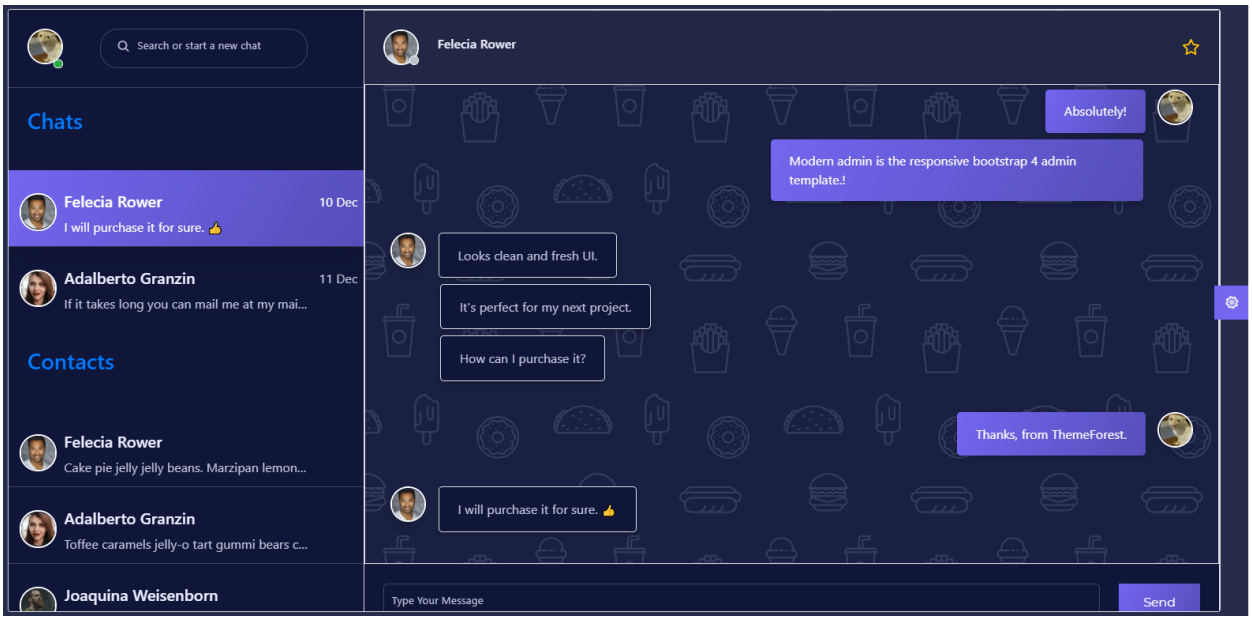

Figure 18: Instant messages

Figure 1 shows the chat feature that was added to the artefact, each member will be able to see their "Chats" on the left of their screens as well as all their team members. On the right side of their screens, they will be able to see their "Chat" as well as be able to send messages to other members of their teams. The "Chat" was added to support the need for an instant messenger feature where members of a team will be able to communicate with each other.

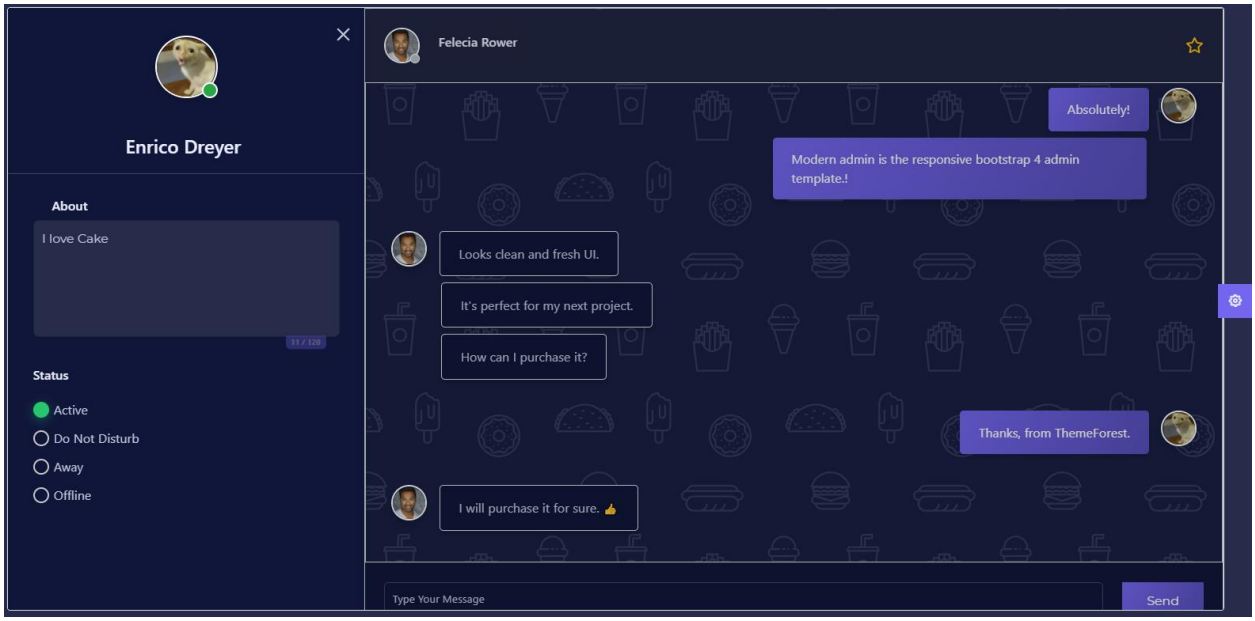

Figure 2: Instant messages Profile

When clicking on your own user profile, you will be able add an "about" that is linked to your profile as well as change your profile status to either "Active", "Do Not Disturb", "Away" or "Offline" as shown in figure 2.

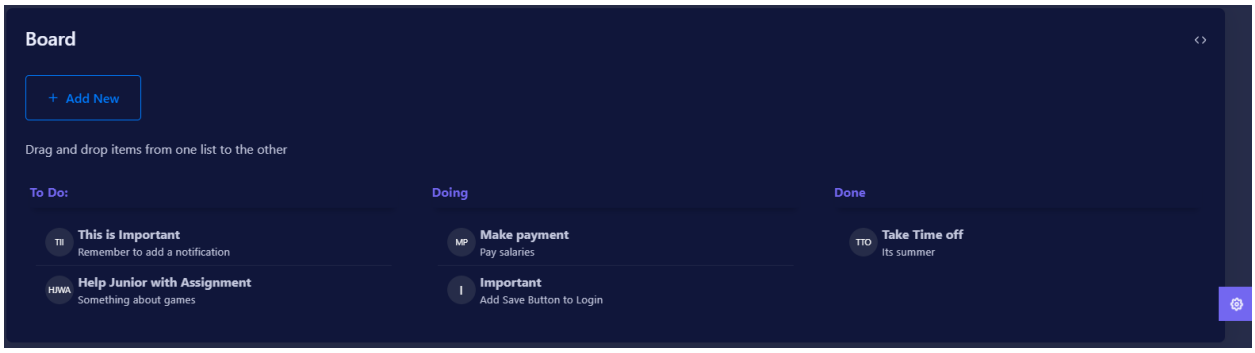

Figure 3: Issue queues

The artefact also focused on Issue queues as another way of communication. As shown in Figure 3, a user can add items to the "To Do" list by clicking on the "Add New" button that will prompt a popup asking them for the detail of the item that they want to add. The user can them move the items to one of the three lists ("To Do", "Doing", and "Done"). This feature improves the flow of activities being done in the project, as well as assist in organizing what needs to be done.

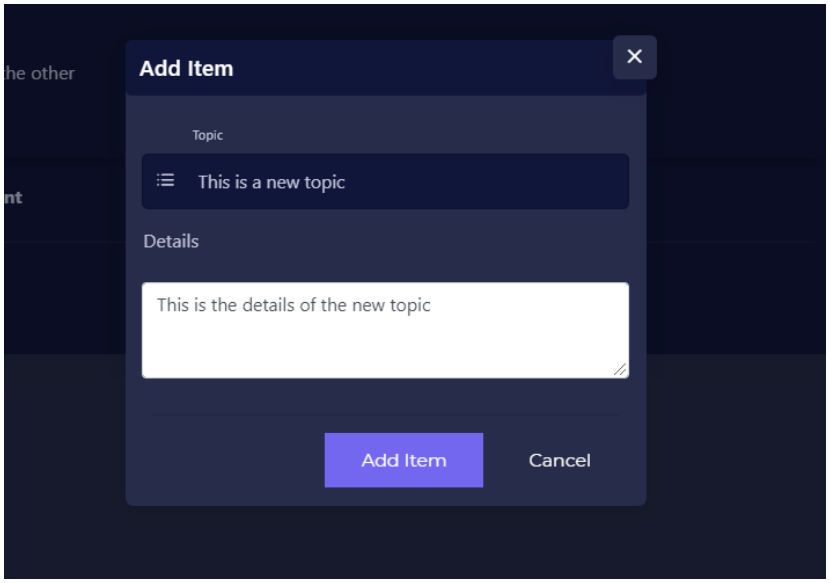

Figure 4: New issue queue pop-up

As shown in Figure 4, the user can add a new item to the drag and drop. The user is obligated to add a topic to the item, along with the details of the item that is added. When the item is added it will display in the "To Do" list.

5.3.2.2. Improve productivity

Figure 5: Team detail

Figure 5 displays information on the team and what they are busy with. This includes seeing the employee number, status, name and surname, email and when they were last online. As a team you work together to reach a common goal, by sharing the information on what each team member is busy with allows for easier sharing of the workload, thus reducing the pressure of each individual (Wehbe, 2017). This feature allows the user to get a broad overview on what is going on in the project. Having a team members email is beneficial for it allows them to have a different communication method if the team member is offline.

5.3.2.3. Focus on both communication between employees but also about project

Figure 6: Project Detail

Figure 6 shows the list of activities that can be added by a user. Each activity consists of a name, category, importance, and a status. Each activity can be either edited or deleted. A user can add a new activity by clicking the "Add New" button, this will prompt a separate component on the right side of the screen. The user can also select multiple activities and choose to either delete or archive the action. A user can also search their activities by using the search function on the top right, along with picking how many activities they want to see at a time.

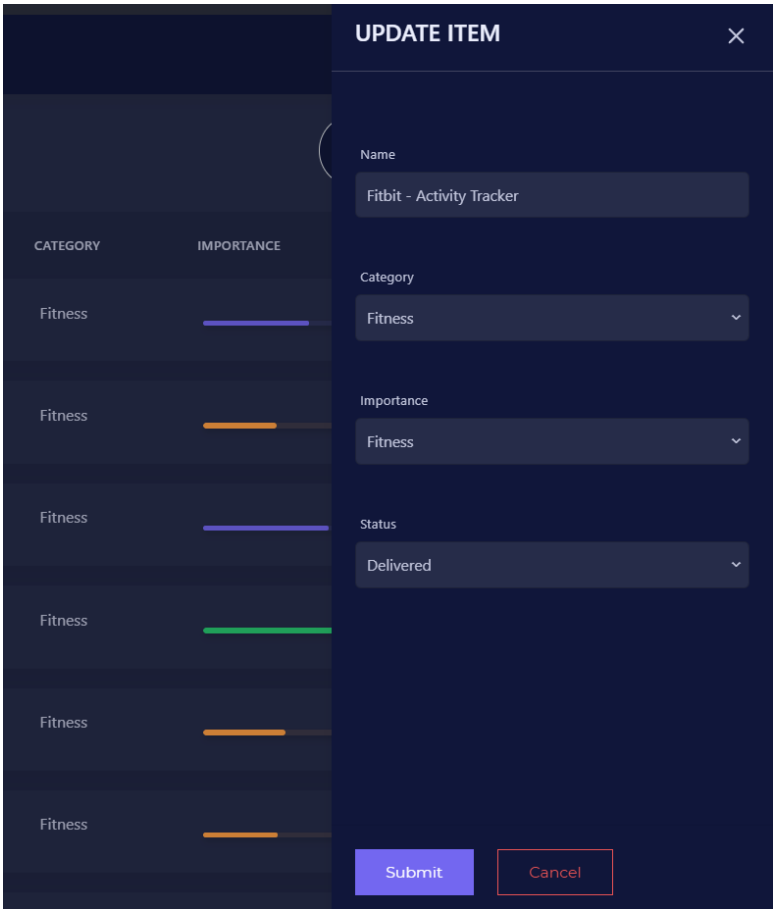

Figure 7: Component for updating or adding an activity

Figure 7 shows the component for adding or updating an Activity. Users can select a "name", "category", "importance", and "status" on this component. After the changes have been made and the submit button has been clicked, the list of activities will update and the component will disappear.

5.3.2.4. Create relaxed environment

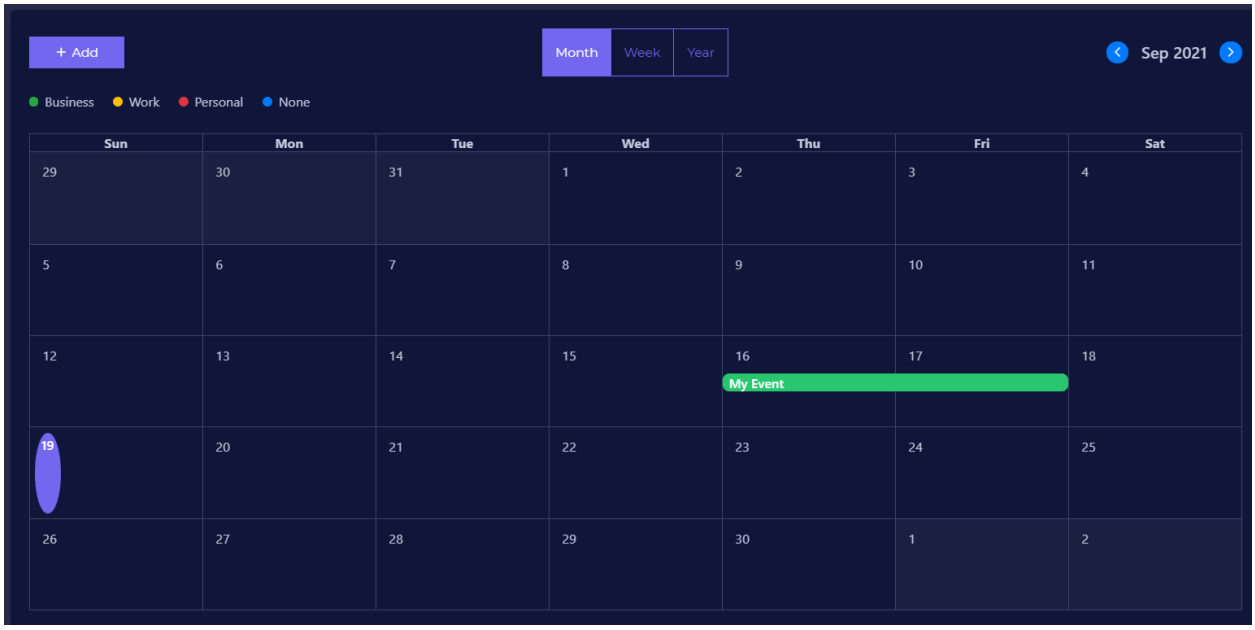

Figure 8: Calendar

Figure 8 shows the users calendar where they can add or edit events. The user can add an event by clicking on a date that will prompt a pop-up asking for the necessary information. The calendar can also be viewed in a "Month", "Week" or "Year" view. When adding an event, users can select a tag that represents either that the event is "Business", "Work", "Personal" or "None", this assists in distinguishing between events. When clicking on an event it will prompt a pop-up with the detail of that event.

According to Hill (2021) a calendar assists in giving a bigger picture on what has to be achieved. Users can plan out their sprints and add events such as meetings that they need to attend. This benefits in terms of setting out time to think and plan for the week ahead, thus creating a more relaxed environment.

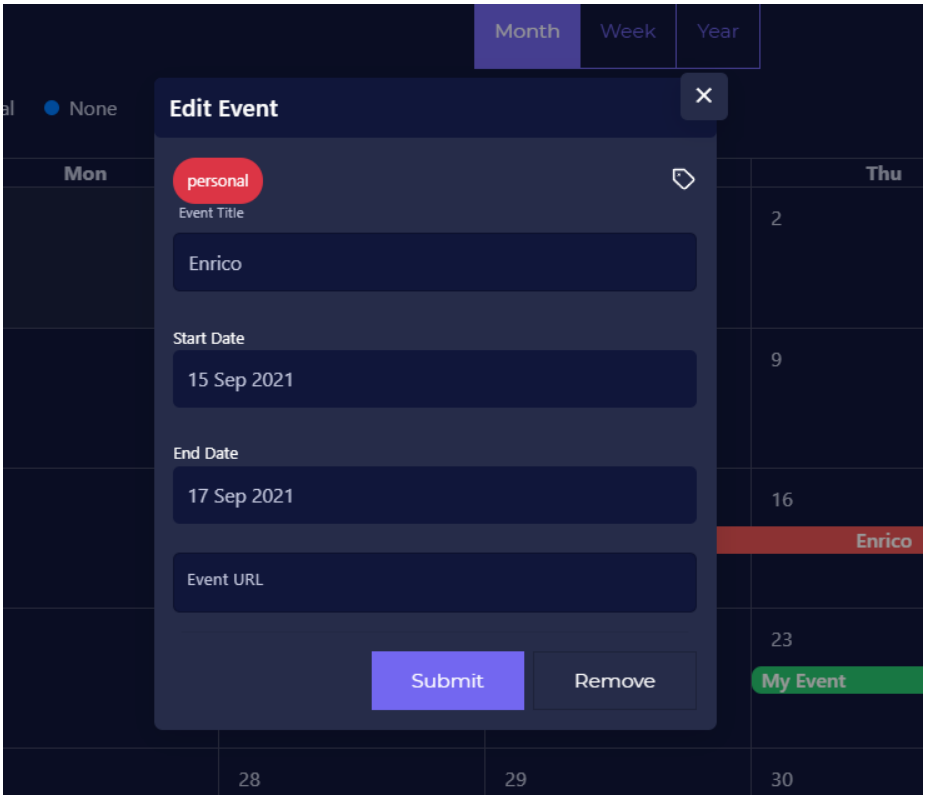

Figure 9: Calendar Edit Event

Figure 9 shows the pop-up when an event is selected. This shows the tag "Personal" as it is marked in red, along with the event "Title", "Start Date", "End Date" and "Event URL". The user can also remove an event or edit a current event by clicking "Submit".

5.3.2.5. User Experience comes first

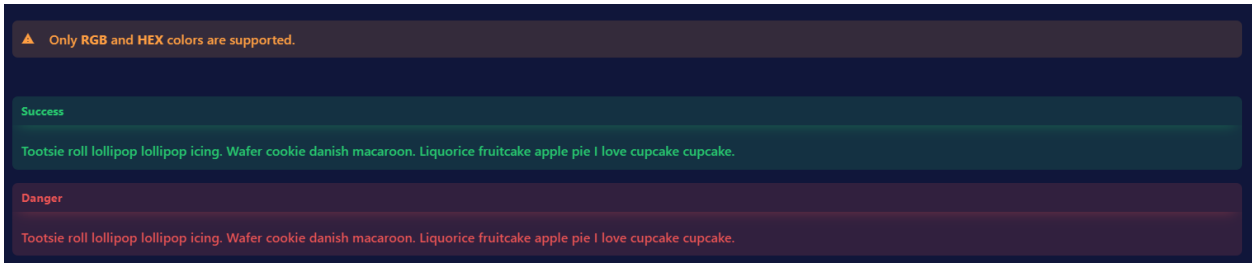

Figure 10: Guidelines for the user

Figure 10 shows dialog from the artefact, this allows for ease of use of the artefact. This requirement flows together with the human-computer interaction as user experience is important as it fulfils part of the user's needs (Gangadharan, 2019). This includes all 10 rules as discussed in Chapter 3 of this study.

The system includes notifications when an action has happened successfully or unsuccessfully. The system has validation on each input of the user, as well as loading elements if the user must wait for data to be retrieved. The user also has the ability to change information that they saved incorrectly.

5.4. Conclusion

The focus of this chapter was the development phase of the Vijay Vaishnavi (2004) process model and giving a visual explain on how each of the requirements or specification was implemented with the use of screenshots and explaining some of the features that was added and how to use them. Along with the requirements and specifications gathered from the interview in Chapter 4, the development of the artefact made use of the human-computer interaction rules discussed in Chapter 3.

The conclusion was that the artefact improved both communication and productivity in the company. The Artefact did not only focus on communication between employees, but also communicate important information about the project that they are working on. The artefact created a more relaxed environment in the company, while making it easier for the users to interact with the communication aspect that is required in the industry.

Chapter 6: Conclusion

The goal of this study is to develop a web application that can be used to enhance communication between developers and management at a South African software development company.

This chapter will focus on giving a summary of the study in Section 2, followed by limitations and future research in Section 3. Section 4 follows with a conclusion of the study.

6.1. Summary of the study

This study consisted of six chapters. Each of the chapters discussed the following:

Chapter 1 – Effective communication is essential for a business since it enhances engagement between employees and strengthens relationships with clients (Zambas, 2019). The overall efficiency in the work environment improves because of effective communication (EasyWorkNet, 2019). This Chapter was an introduction to the study and highlighted key concepts of the study. The primary and secondary objectives was also discussed in detail.

Chapter 2 – This chapter focused on the research methodologies. The founding's was that design science research was the most suitable research methodology to achieve the aims and objectives of this study through the creation of an artefact. The chapter also explained the research process as well as the design science research framework.

Chapter 3 – This chapter focused on the literature review of the study. An evaluation to improve the communication using different communication methods and user interface design in a software development environment was done. Research on different communication methods was also done to understand the advantages and disadvantage of each communication method. Research on human-computer interaction was done to guide with the understanding of what the difference between a good and a bad system is, thus giving background on designing the artefact, and using past research on user experience.

Chapter 4 – This chapter discussed the analysis and data gathering of the study. The chapter gave background of the participant as well as discussed feedback from the interview that was held. An analysis of the feedback was done with the use of open coding. The chapter ended with a list of requirements and specifications, as it formed part of the suggestion phase while developing the artefact.

Chapter 5 – This chapter focused on designing and developing the artefact. The artefact was designed according to the requirements and specifications from the data gathered in the suggestion phase. The human-computer interaction rules formed part of the requirement "user experience comes first".

Chapter 6 – This chapter focuses on the conclusion of the study and gives a summary of each chapter. Limitations and future research are also discussed as well as a formal conclusion of the study.

6.2. Objectives and how it was achieved

1.1.1 3.1. Primary objective

To develop a web application for a South African software development company that allows for easy access to important communication relating to specific projects. This objective was achieved by following the Vijay Vaishnavi (2004) process model and developing an artefact according to a set of requirements and specifications. By using the Vijay Vaishnavi (2004) process model it aided in establishing the design as a coherent discipline and aid in flow of phases in the artefact.

1.1.2 3.2. Secondary objectives

(i) Theoretical objectives

- Gain knowledge of design science research to guide the development of an artefact. This objective was achieved in Chapter 2 of the research paper where the focus was on the different research methodologies and what the most suitable research methodology was.
- To identify commonly used communication methods in the industry. This objective was achieved in Chapter 3 where research was done on different

communication methods to understand the advantages and disadvantage of each communication method.

(ii) Empirical objectives

- To collect and analyse qualitative data in the form of an interview in order to understand what people in the software development industry need to make communication easier. This objective was achieved in Chapter 4 where an interview was held to establish requirements and specifications of the artefact. This greatly improved the artefact and gave a guidance to the development phase.
- To develop a communication web application that will provide easy access to desired communication. This objective as achieved in Chapter 5 where an artefact was developed according to the requirements and specifications from the suggestion phase of the Vijay Vaishnavi (2004) process model.

6.3. Limitations and future research

The nature of and scope of the research paper is limited and forms part of an NWU Honours project. Some aspects were excluded from the study and can be improved on in a further study.

- More participants in the suggestion phase of the study, thus improving the artefact as well as give more insight into designing and further improving the communication between employees.

- Having a wider scope would allow for more requirements and specifications, thus providing more features added to the artefact.

- Using more than one data gathering technique during different stages of the study would have been beneficial to improving the artefact at various stages. Seen as the only data gathering technique used was a semi-structured interview.

6.4. Conclusion

In the software development industry, communication remains a vital component of the core business. A typical process followed in the software development industry entails a client communicating requirements to a project manager and, the project manager communicating the requirements to the developers. When those requirements are

poorly communicated, it can affect the quality of the end product, waste time, resources and that translates to money being lost (EasyWorkNet, 2019). Thus, it is important for all the key stakeholders to have a good communication system.

The goal of this study is to develop a web application that can be used to enhance communication between developers and management at a South African software development company. The system will allow project software developers to have access to important information with ease. Theoretical concepts that are applicable to this study were: design science research, building an artefact, productivity, communication, and agile software development.

Design science research was the most suitable research methodology to achieve the aims and objectives of this study through the creation of an artefact. The process model used in the study was the Vijay Vaishnavi (2004) process model. The process model established the design as a coherent discipline and aided in establishing in what phase the project was at any given time (Mohammad Abooyee Ardakan, 2009). The process model focused on the performance and development of artefacts, intending to improve an already functional artefact.

An evaluation to improve the communication using different communication methods and user interface design in a software development environment was done to gain knowledge on possible solutions to be added to the artefact. Ten human-computer interaction rules were identified and followed while developing and designing the artefact.

Feedback was gathered with the use of a semi-structured interview and analysed with the use of open coding. The data analysis resulted in five requirements and specifications, namely: improve communication, improve productivity, the artefact should focus on communication between employees and communication about the project, create a relaxed environment and the user experience comes first. The human-computer interaction rules formed part of the requirement "user experience comes first".

The goal of the study was achieved by presenting a web-application meeting all the requirements and specifications. The artefact can be used to enhance communication between developers and management at a South African software development company.

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